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WISCONSIN WASTE REDUCTION AND RECOVERY PLAN

Bureau of Solid Waste Management
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WASTE REDUCTION AND RECOVERY PLAN

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Prepared By
Bureau of Solid Waste Management
Wisconsin Department of Natural Resources

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This plan sets goals and strategies to reduce further the amount of waste being landfilled by promoting the reduction of the quantity of waste generated, the reuse, recycling and composting of materials, and the recovery of energy from waste. The document comes up with an action plan for implementation and includes appendices of waste quantities and composition calculations; technologies for alternative waste reduction, recycling, and recovery; state statutes and administrative codes; and a bibliography of the Department of Natural Resources' publications on recycling.

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I. INTRODUCTION

Solid Waste -- also known as the third pollution -- is often the most visible local environmental issue in Wisconsin. In contrast to air and water pollution issues, solid waste management directly affects citizens and local units of governments as well as business and industry. The visibility of these issues is especially high as local landfills are closed or as new landfills are proposed.

Waste reduction and recovery cannot only reduce the need for landfilling, but can also reduce the potential environmental impact and public concern over solid waste disposed. Already, over 20 million tons of material are recovered for reuse in Wisconsin each year. This plan sets goals and strategies to further reduce the amount of waste being landfilled by promoting the reduction of the quantity of waste generated, the reuse, recycling and composting of materials, and the recovery of energy from waste. It is expected that this plan will be updated frequently in response to changes in waste quantities and composition, waste reduction and recovery technologies, market conditions, and state and federal laws.

II. THE NEED FOR WASTE REDUCTION AND RECOVERY

Each year, approximately 6 1/2 million tons of solid waste are disposed in Wisconsin as shown in the following table. The state has nearly 1050 landfills, of which only 90 are classified as "approved" sites, meeting the current state standards for location, design, operation, closure, and long term care. The other 960 sites were built before the current standards were implemented and are being upgraded or closed when filled or as pollution impacts are documented.

Table II-1

Estimated Landfilled Waste in Wisconsin
1983

Category	Tons
Municipal (Household, Commercial and Industrial Not Otherwise Listed)	3,238,000
Pulp & Paper Mill Sludge	1,517,000
Coal Combustion Ashes and Sludges	1,087,000
Foundry Wastes	443,000
Other Non-hazardous	309,000
Municipal Wastewater Treatment Plant Sludges	14,000
Hazardous Waste	8,000
TOTAL	6,616,000

Source: Waste Management Fund Records

Although modern, engineered sites minimize the environmental impact of solid waste disposal, some impacts cannot be avoided. First, the disposal of solid waste often removes valuable land from other uses such as agriculture. Wisconsin's landfills cover over 14,000 acres, or the equivalent of 70 average Wisconsin farms. Dust, noise, traffic and leachate are other unavoidable impacts of landfills. Leachate -- the liquid formed when water soaks through the waste -- can be a major environmental problem at unengineered or poorly operated landfills. Sites that are engineered and properly operated will minimize the migration of leachate to the groundwater, but groundwater quality can be adversely affected from sites that are improperly constructed or operated. Landfills are also expensive, with new landfills having a tipping fee ranging from $15 to $25 a ton. The estimated statewide cost of land disposal is $75 million a year. Finally, the siting of new landfills is a time consuming and controversial process. It is time consuming because of the extensive procedures needed to select the proper location, to adequately design the facility, and to address political and citizen concerns about the proposed site. It is a controversial process because citizens near the proposed site and the local government in which the site is to be located are concerned about safety, pollution of the air, water and land, and about local property values. In addition, the burial of waste is a loss of natural resources and energy. It is estimated that each year in Wisconsin, we bury the paper from over 20 million trees, 1-1/2 billion metal cans, almost a billion glass bottles, 400 million plastic containers, over 4 million tires and 500,000 tons of food and yard waste. Our landfilled waste has the energy of over 200 million gallons of gasoline.

While landfills will continue to be needed even with the most comprehensive waste reduction and recovery system, the demand for landfill space can be significantly reduced, simultaneously reducing the impacts of landfills.

Waste reduction and recovery has other advantages as well as minimizing landfill needs. Probably the most obvious is the conservation of natural resources and energy. In Wisconsin, over 20 million tons of material are recovered annually (see Table II-2). However, there remains large quantities that are still landfilled. Nationally, about 20% of all used paper is recycled. The other 80% is disposed, primarily by landfilling. Only 5% of all glass bottles and jars are recycled in the U. S. While 260,000 tons of coal ash are recycled into cement, roofing shingles and abrasives, over 1 million tons are not reclaimed but are landfilled. And only minor amounts of plastic bottles, tires, and food and yard waste are recycled. Only for metal is recycling a significant percentage, as approximately 50% of the nation's aluminum cans are recycled, along with about 50% of our nation's use of lead, 56% of the national use of copper and 27% of the country's use of iron and steel. Besides conserving materials, recycling also saves energy. For every ton of newspapers recycled, for example, the energy equivalent of 100 gallons of gasoline is saved. Using waste for fuel also conserves energy, as solid waste has approximately half the energy value of coal. Through recycling and resource recovery, Wisconsin could recover enough energy to heat 300,000 homes every year.

Table II-2
Recovered Resources in Wisconsin
(Tons A Year)

Category	Quantity
Municipal Wastewater Treatment Plant Sludge	8.25-8.50 million tons
Cheese Whey	4.05 million tons
Ferrous Metals	1.5 million tons
Pavement	1.5 million tons
Wood	1.5 million tons
Waste Paper	over 1.3 million tons
Sulfite Liquor	1.0 million tons
Coal Ash	260,000 tons
Rendering	250,000 tons
Pulp/Paper Mill Sludge	over 100,000 tons
Hazardous Wastes	70,000 tons
Energy Recover	68,000 tons
Glass	35,000 tons
Aluminum Cans	12,000 tons
Yard Waste Composting	over 5,000 tons
	19.90-20.15 million tons

Also recovered: demolition debris, wood pallets, clothing, plastics, non-ferrous metals, wood pallets, agricultural residues, retreaded tires, reused appliances , furniture and automobiles and machinery.

Recycling and resource recovery also provides industry with a new source of raw materials. These materials are produced locally, reducing the need for importing raw materials from other states or other countries, keeping more dollars in the Wisconsin economy, and avoiding the costs and potential delays of long distance transportation. Industries using recycled materials reap many benefits. Studies sponsored by the U.S. Environmental Protection Agency found that the manufacture of products using recycled material reduces the amount of air pollution, water pollution and solid waste generated when compared to the use of virgin materials, as shown in the next table:

Table II-3

Reductions in Environmental Imports from the
Use of Recycled Materials
(Percent Reduction as Compared to Virgin Material Use)

	Paper	Steel	Glass
Water Use	60%	40%	50%
Water Pollution	35%	76%	-
Air Emissions	73%	86%	6-22%

Source: First Report to Congress. Resource Recovery and Source Reduction. U.S. Environmental Protection Agency, 1974.

However, probably the biggest advantage to industry for using recycled material is that recycled materials escalate in price slower than do virgin materials. For example, as shown in the following table, recyclable paper prices have increased far less than virgin materials on both a percentage and on an absolute basis, as well as far less than the increase in the general rate of inflation, as expressed by the Consumer Price Index, which increased 250% from 1951 to 1981.

Table II-4

Costs of Recyclable and Virgin Materials
(Mill Prices Per Ton)

	January 1951	January 1981	Dollar Increase	Percent Increase
Recyclable Materials				
#1 Newsprint	$38	$50	$12	32%
Old Corrugated Containers	$52	$45 to $50	-$7 to -$2	-4% to-13%
Virgin Materials				
Groundwood	$ 85 to $100	$190 to $200	$105 to $100	100% to 124%
Bleached softwood sulfate	$135 to $165	$465 to $470	$330 to $305	185% to 226%

Source: Official Board Markets

For iron and steel, a similar situation exists. While Number 1 heavy melting scrap steel prices rose by 124% from 1962 to 1982, finished steel product prices rose by 308% during the same time period.

Recycling and resource recovery also provides employment. A typical recycling program requires one worker for each 400-600 tons of material recycled annually, while a typical 100 ton per day energy recovery system employs 10 to 15 people.

III. WASTE REDUCTION AND RECOVERY GOAL

In the mission statement of the Bureau of Solid Waste Management, the goal for recycling is stated as follows:

> "Encourage recycling and other integrated waste management techniques, which ensure maximum reuse of recoverable materials and energy and results in the overall reduction of the volume of solid and hazardous wastes which are land disposed."

Department Secretary Besadny has established a 1990 goal for a 50% reduction in landfilling. The next table gives the long-term goals for waste reduction and recovery. These goals are based on the composition of Wisconsin wastes, the experiences of others, and data from industry sources. Appendix B provides additional details.

Table III-1

Waste Reduction and Recovery Goals

Waste Type	Waste Reduction & Recovery %	Tons
Municipal, Other Non-Hazardous	65%	2,307,500
Reduction	(up to 2%)	-
Reuse	(up to 2%)	-
Recycling	(10%)	(351,000)
Composting	(10%)	(375,000)
Energy Recovery	(45%)	(1,581,500)
Pulp and Paper Mill Sludge	75-90%	1,138,000-1,365,000
Coal Ash	75-90%	815,000-978,000
Foundry Waste	60-70%	266,000-310,000
Municipal Wastewater Treatment Plant Sludge	100%	14,000
Hazardous Waste	100%	8,000
TOTAL	69%-75%	4,548,500-4,982,500

IV. SPECIFIC OBJECTIVES AND STRATEGIES

Reaching the goal of minimizing the use of landfills and maximizing waste reduction and recovery requires a multi-faceted approach. The following objectives and strategies describe the specific approaches to be used to reach the overall goal. These strategies are to be implemented in cooperation with other state agencies, local units of government, industry and individual citizens and community organizations.

Strategy 1

Promote the philosophy, benefits and limitations of waste reduction and recovery alternatives to diverse interest groups throughout the state.

Objectives

Information and education programs on alternative waste management techniques will be developed and presented throughout the state. In July, 1985, a special issue of the DNR Natural Resources magazine focused on waste reduction and recovery. The Department also has developed fact sheets and displays on recycling along with a series of work activities for 4-H members. Specific additional activities will include:

A. Annually, a series of newspaper articles, with 5 articles per fiscal year.

B. Submit articles to environmental and public works magazines and newsletters, with a minimum of 6 publications a year.

C. Designate an annual state recycling week.

D. Conduct a statewide poster and essay contest for school children on waste reduction and recovery, to be held annually.

E. Develop a slide program on the benefits of waste reduction and recovery, by January 1, 1986.

F. Develop curricular material on recycling for schools, by July, 1986.

Strategy 2

Promote an integrated or systems approach to the conservation, recovery and disposal of solid waste to consider all practicable alternatives with priority given to those techniques that produce the greatest environmental and economic benefits.

Objectives

Under 1983 Act 426, landfill applicants are now required to explore alternatives to the land disposal of waste. Other activities to promote an integrated approach includes:

A. Incorporate a hierarchy of (1) waste reduction, (2) reuse, (3) recycling, (4) composting, (5) material and energy recovery, and (6) sanitary landfills into administrative codes for solid and hazardous waste by July 1, 1986.

B. On an ongoing basis, conduct studies into efforts to expand opportunities for alternatives to land disposal in accordance with the hierarchy of waste management options.

C. On a continuous basis, provide technical assistance to individuals, communities, businesses and industries for alternatives of waste management including the development of fact sheets, slide programs, an annual conference, and responding to requests for assistance.

Strategy 3

Have state and local government take a leadership role in promoting and implementing waste reduction and recovery.

Objectives

Act 426, Laws of 1983 required all state agencies to examine their programs and their effect on waste management to recommend changes to promote reduction and recovery by January 1, 1985. Additional measures to be taken include:

A. On an ongoing basis, encourage state agencies to examine their policies and administrative codes and governing statutes for possible changes to facilitate waste reduction and recovery.

B. Encourage state and local government procurement of products containing recycled materials where economically and technically feasible.

C. Expand the collection of recyclable materials within state office buildings, reaching 50% participation by January 1, 1987.

D. On a continuous basis, promote cooperative waste recovery programs between local units of government.

E. Continue to provide grants to communities for feasibility studies on recycling and resource recovery.

Strategy 4

Provide all citizens in the state with the opportunity to recycle, compost, or recover their waste to the extent it is economically feasible.

Objectives

A. On a continuous basis, promote the establishment of community programs for recycling, composting and waste recovery and provide technical assistance as requested, with emphasis on those centers required under state law for waste oil, newspaper, aluminum, glass and plastic.

B. By July 1, 1986, develop administrative rules for landfill owners and municipalities to develop recycling collection centers as required by 1983 Act 426.

C. By July 1, 1986, develop administrative rules for land disposal facility feasibility reports to include an examination of alternatives to land disposal as required by 1983 Act 426.

Strategy 5

Emphasize the reduction and recovery of large volume wastes (both industrial and municipal -- See Table A-1).

Objectives

In the spring of 1985, the Department developed recommendations for changes to legislation, administrative codes and policies to encourage the reduction and recovery of large volume industrial wastes. Additional recommendations will be provided as this program develops. Other objectives are:

A. As provided by state statutes, add staff by January 1, 1986, to provide technical assistance and regulatory review of projects to recycle or recover large volume industrial wastes in response to 1983 Act 426. Additional recommendations will be developed as recycling programs are implemented.

B. Data on waste quantities will be compiled from waste generators through the reporting requirements of the Waste Management Fund, and studies on waste composition will be encouraged through the funding of special study projects on recycling and resource recovery and areawide waste reduction and recycling plans.

C. By July 1, 1987, a list of key applications to recycle or recover high volume industrial waste will be identified in cooperation with major industrial solid waste producers. Those reuse applications with the greatest potential will be identified for demonstration and/or implementation.

Strategy 6

Emphasis will be placed on the reduction and recovery of wastes which have the greatest potential for environmental pollution if land disposed.

Objectives

Already the Department has taken significant steps to encourage the reduction and reuse of hazardous wastes. In the spring of 1985, recommendations were developed for legislation to encourage alternatives to land disposal for hazardous wastes as required by 1983 Act 426. The Bureau of Solid Waste Management promotes the participation of hazardous waste generators in the Industrial Materials Exchange Service waste exchange. Finally, the Bureau has rewritten the hazardous waste administrative rules to facilitate the reduction, reuse, recycling and recovery of hazardous ~~and~~ wastes by providing exemptions for beneficial reuse and for off-site accumulation sites. Other measures to be developed are:

A. On a continuous basis, provide technical assistance to generators of hazardous wastes to find alternatives to land disposal, with emphasis on small generators. These generators often do not have technical staff available to provided needed information.

B. By July 1, 1986, NR 181 will be modified to require all applicants for hazardous waste processing, treatment and disposal facilities to examine alternatives of waste reduction and reuse.

Strategy 7

Promote measures to expand existing markets and develop new markets for recoverable materials and energy.

Objectives

The Department has reviewed programs of other states to encourage recycling and has recommended changes to Wisconsin statutes to expand existing markets and encourage the development of new markets. Future activities include:

A. Profile existing markets for recycled materials by January 1, 1987.

B. On an on-going basis, encourage the procurement of recycled materials, especially by state and local government.

C. Conduct research into impediments to recycling and recommend measures to remove these impediments and possible incentives to encourage recycling, on a continuous basis.

D. Continue the funding for the demonstration grant program to sponsor research into new markets for recoverable materials and energy.

E. As needed, review and comment on federal programs that affect recycling.

F. On an on-going basis, encourage and assist local communities and industries to develop new uses for recyclable materials.

G. On an on-going basis, explore financial and other incentives to encourage market development, including programs of other states.

Strategy 8

Provide financial and technical assistance to individuals, communities and businesses for establishing, operating and improving recycling, composting and recovery programs.

Objectives

In the spring of 1985, the Department recommended new state legislation to provide financial incentives for the recycling and recovery of solid waste. Future activities include:

A. Continue grants programs for both feasibility studies and demonstration projects.

B. Every two years, update and distribute a statewide directory of recycling markets.

C. Prepare and distribute fact sheets on recycling, composting and energy recovery as needed.

D. Provide assistance on recovery and resource recovery on request.

E. Sponsor an annual conference on the recycling and recovery of solid waste.

Strategy 9

Facilitate the environmental review and licensing of recycling, composting and resource recovery projects.

Objectives

As part of this effort the Department has revised the hazardous waste administrative rules to encourage recycling. Other measures to be taken are:

A. By July 1, 1986, revise the solid waste management administrative rules to encourage the composting of vegetative material and to create rules to encourage experimental projects for the land based recycling of large volume industrial wastes.

B. By January 1, 1986, hire additional staff to provide environmental review and technical assistance for recycling and resource recovery projects of large volume industrial waste.

C. In cooperation with the Bureau of Air Management, explore ways to provide technical and/or financial assistance to the developers of solid waste energy recovery incinerators for the control of air emissions from energy recovery projects.

D. As needed, identify and conduct research into the air, water and solid waste impacts of recycling, composting and energy recovery projects to outline techniques and technologies to minimize any adverse environmental impacts.

Strategy 10

Promote local, state and federal laws, regulations and policies that either require or encourage recycling, or, at a minimum, do not inhibit or discourage recycling.

Objectives

In the fall of 1984 and spring of 1985, the Department assisted other state agencies in identifying activities that affect recycling and proposing recommendations to encourage recycling to fulfill the requirements of 1983 Act 426. We will continue to assist other state agencies as well as pursuing the following activities:

A. On a continuous basis, assist local governments in examining local laws affecting recycling and enacting laws, ordinances and policies encouraging recycling.

B. On an ongoing basis, review federal programs affecting recycling in cooperation with congressional delegation.

Strategy 11

Wherever possible, the recycling or recovery of materials should be coordinated with or implemented by private enterprise to insure that the development of new recycling or recovery programs does not unduly disrupt existing recycling dealers and markets.

Objectives

A. Meet with representatives of the recycling industry on a regular basis to obtain their suggestions and feedback and to coordinate state activities to encourage and assist recycling.

B. Periodically, conduct market research studies to develop methods to expand or improve markets for recyclable materials.

C. Every two years, update the recycling markets directory and distribute it to local governments throughout Wisconsin.

Strategy 12

Promote the manufacture of recyclable products.

Objectives

A. By January 1, 1986, prepare a report that explores alternative techniques to increase the recyclability of products.

B. By July 1, 1986, have trade associations of major industries review above report and work with industry to voluntarily adopt manufacturing techniques that promote recycling of their products.

C. By January 1, 1987 suggest state legislation to increase the recyclability of products.

V. RESPONSIBILITY FOR ACHIEVEMENT

Ultimately, the responsibility for waste reduction and recovery lies with the manufacturers of products, the generators of solid and hazardous waste, and the solid and hazardous waste management profession, including both private industry and local government. The state's role is to develop overall goals, and to encourage their achievement through policies and programs of information/education, technical assistance, financial assistance, and regulations in conformance with state law.

The responsibilities of the Department are discussed below, divided by the four major waste categories.

Municipal Waste

Municipal waste include household, commercial, and industrial waste excluding the large volume waste of pulp and paper mill sludges, coal combustion ashes and sludges, and manufacturing process waste from foundries. Municipal waste also does not include commercial or industrial quantities of hazardous waste but does include household hazardous wastes.

For these wastes, the recycling staff in the Bureau of Solid Waste Management has the major responsibility for the development of the Department's overall waste reduction and recovery program, including implementing information and education activities, providing technical assistance, and formulating recommendations to the Department Secretary for changes in federal or state law to promote the development of markets for recoverable material and energy. The recycling staff also takes the lead in developing administrative rules to implement state laws on waste reduction and recovery, excluding those issues related to the environmental impacts of waste reduction and recovery, for financial assistance, and for hazardous waste management. These are respectively the responsibilities of the Residuals Management and Land Disposal Section, the Systems Management Section and the Hazardous Waste Management Section.

The Residuals Management and Land Disposal Section has primary responsibility for the review of proposed waste reduction and recovery facilities that are subject to environmental regulation. The recycling staff provides assistance to the section in the development of administrative rules governing waste reduction and recovery facilities, in the review of the analysis of alternatives in land disposal feasibility reports, and on other issues upon request.

The Systems Management Section has primary responsibility for administrating the solid waste management grant program. The recycling staff provides assistance in the development of administrative rules, in review of grant applications, and in review of reports for special study projects, areawide waste reduction and recovery plans, and waste reduction and recovery demonstration projects. The Systems Management Section also assists the recycling staff in developing information and education materials and programs.

The district and area staff responsibilities are to review the waste reduction and recovery alternatives section of land disposal feasibility reports, review special study projects and demonstration projects or recycling and resource recovery feasibility studies of those recycling and resource recovery facilities for which review is decentralized, and to inspect recycling and resource recovery facilities as appropriate. They also provide general information on state recycling program requirements to affected audiences, with referral to the central staff for detailed information, technical assistance, and financial assistance.

Large Volume Industrial Waste

Large volume industrial wastes in Wisconsin include pulp and paper mill sludges, ashes and sludges from coal combustion facilities, and manufacturing process wastes from foundries.

There are three major areas in which the Department has involvement in the management of large volume industrial waste.

The first area is in the regulation of industrial wastewater including the generation of pulp and paper mill sludges. The Bureau of Wastewater Management, Industrial Wastewater Section, works with industries to promote improvements in manufacturing and wastewater treatment processes to minimize the generation of sludges requiring land disposal.

A second area of Department involvement is the review of environmental impacts of solid waste management practices, including beneficial reuse and recovery. The primary responsibility for this activity is with the Residuals Management Section, Bureau of Solid Waste Management. In addition, district and area staff assist, review and provide on-site inspection of such projects.

The third area of Department activity is financial assistance to promote waste reduction and recovery. The Systems Management Section of the Bureau of Solid Waste Management administers the solid waste management grant program, including waste reduction and recycling demonstration grants, which are available to private businesses as well as local government and non-profit entities. In addition, the recycling staff, in cooperation with other Department staff, provides the Department Secretary with recommendations for changes on federal and state legislation to improve the economic feasibility of waste reduction and recovery.

Hazardous Waste

Currently, Wisconsin does not have a licensed land disposal facility for hazardous waste. Of the estimated 125,000 tons of hazardous waste produced in Wisconsin in 1983, from generators covered by the manifest system, 89,000 tons were treated, reused or recovered, 10,000 tons were stored, and 26,000 tons were landfilled in licensed facilities in other states.

Because of the complexity of the federal and state laws governing the wide range of hazardous waste materials, along with the specialized technical knowledge needed to properly manage hazardous wastes, the Hazardous Waste Management Section has the primary responsibility for developing programs to achieve the waste reduction and recovery goal, strategies and objectives described in Chapters III and IV. Assistance will also be provided by the Industrial Wastewater Section, Bureau of Wastewater Management in working with industry to improve manufacturing and wastewater treatment processes to minimize hazardous waste generation. In addition, the Systems Management Section, Bureau of Solid Waste Management provides both information and education on the applicable state and federal hazardous waste management laws and regulations along with financial assistance for projects that demonstrate innovative waste reduction and recovery projects. The recycling staff will take the lead on encouraging the recycling of waste engine oil and, in cooperation with the Hazardous Waste Management Section, in providing information to people involved in municipal waste recycling programs about opportunities for recycling or safely disposing hazardous waste.

Municipal Wastewater Treatment Plant Sludges

According to Department records, the majority of the municipal wastewater treatment plants sludge produced in Wisconsin is currently being landspread. Out of 250,000 dry tons of sludge produced annually, less than 1,000 dry tons (0.4%) are landfilled. Over 5,500 sites covering 1,000,000 acres have been approved for the landspreading of municipal wastewater treatment plant sludge.

The Bureau of Wastewater Management regulates the treatment of municipal wastewater and both regulates and encourages the landspreading of municipal wastewater treatment plant sludge as an alternative to landfilling. In conjunction with the Bureau's programs, district staff work closely with municipal wastewater treatment plant operators and provide technical assistance for landspreading. In addition, financial assistance for sludge management is available through both the Bureau of Solid Waste Management for feasibility studies and through the Bureau of Water Grants as part of the wastewater treatment grant program for facilities planning, design, and construction.

VI. CHRONOLOGICAL ACTION PLAN FOR IMPLEMENTATION

In this chapter, the strategies given in chapter IV are reorganized into chronological order. Specific objectives are listed by six month intervals until January 1, 1987, along with annual, biennial and on-going tasks. As new legislation on waste reduction and recovery is enacted, it will be necessary to notify the tasks listed. It will also be necessary to modify this action plan as the plan is implemented and additional strategies are identified.

Already, the Department has completed many important tasks on the development of its recycling program, as listed below:

- Compiled waste quantity and composition data from the waste management fund.

- Assisted other state agencies in identifying their activities that affect recycling and proposing recommendations to encourage waste reduction and recovery in compliance with 1983 Act 426.

- Developed a report to the Governor and Legislature of recommendations to encourage and assist recycling and resource recovery, including:

  - economic incentives for market development
  - removal of barriers impeding recycling
  - encouragement of alternatives to the land disposal of hazardous waste
  - encouragement of alternatives to the land disposal of large volume industrial wastes.

- Promoted the participation of hazardous waste generators in the Industrial Materials Exchange Service waste exchange.

- Published a supplement to the Wisconsin Natural Resources magazine on waste reduction and recovery.

- Developed curricular material on recycling for 4-H members.

- Developed several displays on solid waste reduction and recovery for use at the state fair, solid waste conferences and at government office buildings.

- Reviewed programs of other states to encourage recycling.

- Rewrote the hazardous waste administrative rules to facilitate the reduction, reuse, recycling and recovery of hazardous materials and wastes. Exemptions from specific regulations are available for legitimate recovery and reclamation, beneficial use or reuse and incineration for energy recovery. Exemptions are also available for off-site accumulation facilities used to aggregate sufficient quantities of hazardous wastes for recovery and disposal.

- Established interim guidelines for landfill applicants to analyze alternatives to the land disposal of waste in accordance with 1983 Act 426, s.s. 144.44(2)(f)7 and 8.

However, these tasks are only a beginning and more work needs to be done.

The following tasks are to be completed by January 1, 1986.

- Develop slide programs on the benefits of recycling, how to establish a recycling program, and on composting.

- Create rules to facilitate experimental projects for the land based recycling of large volume industrial wastes.

- Hire additional staff as approved by state statutes to provide environmental review and technical assistance for recycling and resource recovery projects of large volume industrial waste.

- Revise NR 186 to administer the demonstration grant program.

- Add staff to provide information and education on a state and federal requirements and opportunities for recovery or disposal to small quantity hazardous waste generators.

By July 1, 1986, complete the following strategies:

- Incorporate the hierarchy of 1) waste reduction, 2) reuse, 3) recycling, 4) composting, 5) material and energy recovery, and 6) sanitary landfills into administrative codes (NR 180, NR 181 and NR 186) for solid waste management, hazardous waste management and the grants program.

- Revise the solid waste management administrative rules to facilitate the composting of vegetative material through exemption of small facilities and specific requirements for large facilities.

- Develop curricular material on recycling for schools.

- Adopt administrative rules for landfill owners and municipalities to develop recycling collection centers as required by 1983 Act 426, s.s. 144.796.

- Adopt administrative rules for land disposal facility feasibility reports to include an examination of alternatives to land disposal as required by 1983 Act 426, s.s. 144.44(2)(f)7 and 8.

- Prepare a report that explores alternative techniques to increase the recyclability of products.

By January 1, 1987, the following tasks are to be completed:

- Hire field staff to provide assistance to local units of government individuals and businesses on establishing and operating waste reduction and recovery programs.

- Profile existing markets for recycled materials.

- Recommend state legislation to increase the recyclability of products.

- Expand the collection of recyclable materials within state office buildings, reaching 50% participation.

- A list of key applications to recycle or recover high volume industrial waste will be identified in cooperation with major industrial solid waste producers. Those reuse applications with the greatest potential will be identified for demonstration and/or implementation.

In addition to the previous work items, annually, the following tasks are to be completed:

- Designate a state recycling week.

- Conduct a statewide poster and essay contest for school children on waste reduction and recovery.

- Sponsor a statewide conference on recycling and resource recovery.

- Write and distribute a series of at least five newspaper articles.

- Write at least six articles for environmental and public works magazines and newsletters.

Biennially, the directory of community recycling programs and the directory of recycling markets is to be updated and republished.

Along with the tasks listed above that have a specific time schedule, there are many on-going tasks which are either done periodically as needed, or upon request. No priority is assigned, nor is it possible to establish quantifiable goals for each task.

- Meet with representatives of the recycling industry to obtain their suggestions and feedback and to coordinate state activities to encourage and assist recycling.

- Review federal programs affecting recycling in cooperation with the state congressional delegation and the Department Secretary.

- Promote the establishment of community programs for recycling, composting and waste recovery and provide technical assistance as requested, with emphasis on those centers required under state law for waste oil, newspaper, aluminum, glass and plastic.

- Provide technical assistance to individuals, communities, businesses and industries for alternatives of waste management.

- Encourage and assist governmental agencies, industries and individuals to develop uses for recyclable materials.

- Encourage state agencies to examine their policies, administrative codes and statutes for possible changes to facilitate waste reduction and recovery.

- Provide technical assistance to generators of hazardous wastes to find alternatives to land disposal, with emphasis on small generators.

- Prepare and distribute fact sheets on recycling, composting and energy recovery as needed.

- Continue the grant programs for both feasibility studies and demonstration projects.

- Conduct studies into methods to expand opportunities for alternatives to land disposal in accordance with the hierarchy of waste management options. Both market research and impediments to waste reduction and recovery are to be studied.

- Provide the Department Secretary with recommendations for modifications to state legislation to encourage waste reduction and recovery.

- As needed, identify and conduct research into the air, water and solid waste impacts of recycling, composting and energy recovery projects to outline techniques and technologies to minimize any adverse environmental impacts.

VII. RESOURCES NEEDED FOR PLAN IMPLEMENTATION

This plan establishes ambitious but achieveable goals for reducing the quantity of waste going to Wisconsin's landfills. The plan is only achievable if suitable resources are available for staffing, financial assistance, and market development.

Staff Needs

Based on a review of the work items and responsibilities in the previous three chapters, it appears that the respective bureaus all have an adequate level of staffing. For example, in the Bureau of Solid Waste Management, the Recycling Coordinator and the Assistant Recycling Coordinator have the responsibility for providing information, education and technical assistance, along with assisting the Residuals Management and Land Disposal Section with a review of the analysis of alternatives in land disposal feasibility reports. The Grants Coordinator administers the financial assistance programs of the Bureau, while in the Hazardous Waste Management Section, staff assist industries in examining alternatives of waste reduction and recovery. In the Bureau of Wastewater Management, the Sludge Coordinator oversees the use of municipal wastewater treatment sludges for land spreading, and other staff work with industry on internal waste reduction and recovery processes.

For the field staff, at the present time, there appears to be an adequate level of staffing for the promotion of, and assistance for the reuse of municipal wastewater treatment plant sludges. However, staffing needs should be reviewed for the preparation of the 1987-89 State Budget, to both assess the adequacy of the staffing levels to implement recently enacted programs as well as on the level of federal funding.

In the area of solid waste, however, there is a need for additional staff for the promotion of, and assistance for and review of waste reduction and recovery systems. In particular, additional staff are needed to implement the provisions of 1983 Act 426, in the review of alternatives in land disposal feasibility reports, the review of waste reduction and recovery projects funded by the Department's financial assistance programs, and promoting and enforcing the requirements for waste recycling facilities at landfills open to the public and in communities of over 10,000 people.

At the present time, there are no field staff responsibilities for promoting and assisting waste reduction and recovery programs. This plan establishes these responsibilities and the 1985-87 state biennial budget allocates 3.5 FTE for field staff on recycling including 1.5 FTE for high volume industrial waste and 2.0 FTE for municipal waste recycling. Legislation adopted in the fall of 1985 provides an additional 1.5 FTE for high volume industrial waste. The proposed allocation of these resources is given in Table VII-1.

Table VII-1
Proposed Recycling Field Staff Allocations By District

District	Staff, FTE
Southern	0.5
Southeastern	1.5
Lake Michigan	1.5
West Central	0.5
North Central	1.0
Northwest	-
Total	5.0

These allocations are based on the quantity of high volume industrial waste as well as the quantity of municipal waste landfilled in each district as shown in Table VII-2, below.

Table VII-2
Tons of Waste Landfilled by District
1983

District	High Volume Industrial Waste	Municipal Waste	Total
Southern	296,000	757,000	1,053,000
Southeast	658,000	1,168,000	1,826,000
Lake Michigan	1,150,000	785,000	1,935,000
West Central	239,000	333,000	572,000
North Central	628,000	365,000	993,000
Northwest	78,000	133,000	211,000
Total	3,049,000	3,541,000	6,590,000

(Note: Totals are rounded and do not include municipal wastewater treatment sludge or hazardous waste.)

It is recommended that additional staff be provided to insure compliance with 1983 Act 426, particularly for the requirements for waste recycling and separation facilities at landfills open to the public and in communities of 10,000 people or more. The number of facilities required by district is shown in Table VII-3.

Table VII-3
Required Recycling Facilities Per State Statute 144.796

District	At Landfills	In Communities	Total
Southern	156	20	176
Southeast	47	41	88
Lake Michigan	179	25	204
West Central	183	15	198
North Central	131	11	142
North West	204	11	215
Total	900	123	1,023

It is recommended that an additional 2.0 FTE field staff be provided, with 0.5 FTE to the Northwest, West Central, Southern, and Lake Michigan Districts. Each of these districts has a large number of required waste recycling facilities, in addition, the Southern and Lake Michigan districts also have substantial quantities of high volume industrial wastes. These staff should be added by July 1, 1986, with an annual cost of $70,000.

It is anticipated that these staff could be reallocated in the long range future as the landfills develop waste reduction facilities and when the number of land disposal facilities decreases as unapproved sites are closed as they reach capacity, are shown to be causing environmental degradation, or in accordance with their signed closure agreements.

Financial Assistance

Currently, the Department provides financial assistance for planning and feasibility studies for the reduction and recovery of solid waste and municipal wastewater treatment plant sludge along with financial assistance for the capital cost of municipal wastewater treatment plant sludge management facilities. It is recommended that the state continue these programs, and that state financial assistance also be provided for local communities at a 50% match basis to promote participation in waste reduction and recovery activities. Recommended funding is $100,000 a year, with the maximum eligible grant at $5,000 for communities under 50,000 people and $10,000 for larger communities.

It is also recommended that the state develop a 50% matching grant program for the development and construction of energy recovery facilities, similar to the current state program for the construction of municipal wastewater treatment systems. As described in Chapter III and Appendix C, the goal for energy recovery from municipal waste is a 45% reduction in landfilled waste, requiring a total capacity of 4,700 tons per day. With the current cost of energy recovery facilities at approximately $75,000 to $100,000 per daily ton, this will require a total investment of $377,000,000 to $470,000,000 in 1985 dollars, or at a 50% match, a state investment of $188,000,000 to $235,000,000. It is further recommended that construction grants be awarded only for systems that maximize waste reduction, reuse, recycling and

composting, and that the program be funded through a state bond issue to be repaid by a state surcharge on landfilled municipal waste.

Market Development

Recycling or resource recovery of materials and energy from solid waste requires a market for the recoverable product. Without markets, the material can be collected, and the energy can be generated, but neither will be used. State programs are needed to stimulate the expansion of existing markets and the development of new markets. It is recommended that recycling markets be given the same access as manufacturers to state-backed low interest loans and to exemptions from property tax for machinery and equipment. Also, it is recommended that waste reduction recovery equipment be subject to first year expensing of capital costs, similar to state law for pollution control equipment. In addition, it is recommended that the state investigate other financial incentives such as investment tax credits to stimulate the waste reduction and recovery industry. Without adequate markets, the entire waste reduction and recovery effort is in jeopardy of failure.

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APPENDIX A

CALCULATIONS OF
WASTE QUANTITIES AND COMPOSITION

WISCONSIN WASTE QUANTITIES AND COMPOSITION

Calculating the quantity and composition of Wisconsin's solid waste is difficult due to a limited amount of accurate data. Estimates of the quantity of solid waste landfilled in Wisconsin are from the Waste Management Fund, to which all landfillers must contribute based on the amount of waste handled. For landfills without scales, estimates of the weights handled are used as the basis for the fees.

In addition to these data, the Wisconsin Solid Waste Recycling Authority conducted two quantity and composition studies in the state, including residential, commercial, industrial, bulky, and demolition waste. The waste surveys were done as the first step in the development of recycling systems in two parts of the state -- Outagamie, Winnebago and Fond du Lac counties (Region I) and Lincoln, Marathon, Portage and Wood counties (Region II). The Region I study was done in June and July of 1975 while the Region II study was conducted in September and October of 1979. The major limitation of these data is the lack of certainty for their use on a statewide basis.

Another source of information on waste quantities and composition is a survey done in November 1974, in which students from 35 high schools in eastern Wisconsin surveyed their household waste, obtaining data on waste quantities and composition. The survey covered 1,266 households representing 6,862 people. It was sponsored by the National Science Foundation and administered by UW-Green Bay. Using these data along with information from other reports or industry sources, this appendix calculates an estimate of the quantity and composition of Wisconsin's solid waste, summarized in Table A1 on the next page.

Paper

Along with the data described above, a third source of information is a national report published by Franklin Associates in 1982 for the Solid Waste Council of the Paper Industry, and published by the American Paper Institute. Titled Waste Paper. The Future of a Resource, 1980-2000, this report includes estimates for old corrugated containers, old newsprint, and waste office paper for three metropolitan areas in Wisconsin, representing over 40% of the state's population. The limitation of these data is that they report overall waste generation, and do not subtract out the amount already reused or recycled.

Newsprint

In Region I, the Solid Waste Recycling Authority found that 10.1% of the residential waste (125,200 tons per year) and 0.1% of the industrial waste (105,000 tons per year) were newspapers, for a total of 12,600 tons per year.

The population of Region I at the time of the survey was 356,000 people, for a per capita generation of newsprint 0.0354 tons per year. If Region I is representative of the entire state, then an estimated 169,000 tons of newsprint are discarded annually in Wisconsin.

APPENDIX A

CALCULATIONS OF
WASTE QUANTITIES AND COMPOSITION

Table A-1
WISCONSIN 1983
ESTIMATED QUANTITIES OF LANDFILLED WASTE

Category		Tons
Pulp and Paper Mill Sludge		1,517,000
Paper		1,420,000
Mixed	800,000	
Old Corrugated Containers	420,000	
Newsprint	140,000	
Office	60,000	
Coal Combustion Ash		1,090,000
Foundry Waste		440,000
Wood		410,000
Food		300,000
Yard		300,000
Demolition and Bulky		250,000
Metal		245,000
Al Cans	17,000	
Steel Cans	61,000	
Other Metal	167,000	
Plastic (not including bulky, construction, etc.)		205,000
Plastic Bottles	25,000	
Other Plastic Packaging	75,000	
Other Plastics	105,000	
Glass		180,000
Beverage	70,000	
Other Containers	110,000	
Textiles and Leather		80,000
Tires		60,000
Pottery Cull		24,000
Alum Sludge		18,000
Municipal Wastewater Treatment Plant Sludges		14,000
Hazardous Wastes		8,000
Other, Unknown		55,000
	TOTAL	6,616,000

John Reindl, Recycling Coordinator
Wisconsin DNR, July, 1985
6148Y

In Region II, the Authority survey found that newspapers were 9.1% of the residential waste, with no newspapers in either the commercial or industrial waste streams. The average per capita figure is 0.0278 tons per year, or if Region II is representative of the entire state, 133,000 tons of newsprint are landfilled per year in all of Wisconsin.

Turning to the survey done by the high school students, it was found that the average person produced 0.202 pounds of newsprint per day, or for the entire state, 176,000 tons a year. The difference between this figure and the estimates from Regions I and II could reasonably be assumed to be the amount recycled, burned or put to other uses.

A fourth method of estimating waste newspaper generation is from the American Paper Institute (API) study, which estimates that 159,500 tons are available annually in the three largest standard metropolitan statistical areas (SMSA) containing 42% of the state's population. Prorating these statistics for the entire state produces an estimate of 376,000 tons of waste newsprint per year for Wisconsin, over double the other three estimates. The reasons for this estimate being so high may include the inclusion of newspapers printed in within the area but sold throughout the state; the larger size and more frequent distribution of newspapers in urban areas; the inclusion of waste newsprint from publishers, which is largely recycled and not landfilled; and the counting of newsprint which is recycled or otherwise reused by homeowners.

Reviewing the four sets of calculations, it is felt that the most accurate and representative are the estimates based on the data of Regions I and II, with a statewide total of between 133,000 and 169,000 tons per year.

Old Corrugated Containers

Old corrugated containers come from residential, commercial and industrial solid waste. The data of the waste surveys of the Solid Waste Recycling Authority in Regions I and II are contained in the next table.

Estimates of Annual Amounts of Old Corrugated Containers (OCC)
Region I

Waste Category	Quantity (Tons)	Old Corrugated Containers %	Tons
Residential	125,200	10.2	12,800
Commercial	58,600	36.1	21,200
Industrial	105,200	16.2	17,000
		TOTAL	51,000

Estimates of Annual Amounts of Old Corrugated Containers (OCC)
Region II

Category	(Tons)	%	Tons
Residential	81,600	8.1	6,600
Commercial	42,100	24.4	10,300
Industrial	47,600	11.5	5,500
		TOTAL	22,400

Based on these data, in Region I, 0.143 tons of old corrugated containers are landfilled per person per year, for a statewide estimate of 685,000 tons, while for Region II, the generation rate is 0.084 tons per capita per year for a statewide total of 403,000 tons a year.

As an alternative method of estimating the amount of old corrugated containers, the API report estimates 1985 generation for the three largest SMSA's at 179,600 tons a year for 42% of the state's population. For the entire state, this is equal to 424,000 tons per year, well within the range of estimates from the waste surveys of Regions I and II.

Mixed Paper

The category of "mixed paper" includes various types of packaging such as cereal boxes, egg cartons, magazines, mail, office paper, cuttings from print shops and similar grades.

The waste surveys of the Solid Waste Recycling Authority for Regions I and II provide the following data:

Estimates Annual Generation of Mixed Paper
Region I

Waste Category	Quantity (Tons)	Mixed Paper %	Mixed Paper Tons
Residential	125,200	5.2	6,500
Commercial	58,600	27.4	16,000
Industrial	105,200	50.2	52,700
		TOTAL	75,200

Region II

Waste Category	Quantity (Tons)	Mixed Paper %	Mixed Paper Tons
Residential	81,600	28.1	22,900
Commercial	42,100	31.2	13,100
Industrial	47,600	23.8	11,300
		TOTAL	47,300

According to these data, the per capita generation of mixed in Region I is 0.211 tons per year, equal to 1,010,000 tons for the entire state. In Region II, the annual per person generation is 0.178 tons, or 850,000 tons for the entire state.

Included in the category of mixed paper is high grade office paper. The API report estimates that is the three largest SMSA's in the state, annual generation is 26,400 tons, or, extrapolated to the entire state, 60,000 tons a year. The remaining types of mixed paper are thus estimated at 790,000 to 950,000 tons a year.

Conclusion

Although the data are not precise, an estimate of the quantity and composition of waste paper landfilled in Wisconsin is shown in the next table.

Estimated Quantities of Landfilled Waste Paper
(Tons Per Year)

Office Paper	60,000	
Newsprint	133,000	- 169,000
Old Corrugated Cardboard	400,000	- 685,000
Mixed Paper	790,000	- 950,000
TOTAL	1,383,000	- 1,864,000

In 1983, about 3,244,000 tons of municipal waste were landfilled in Wisconsin. Based on the estimate of the above table, paper is from 43% to 57% of Wisconsin's municipal waste.

5811Y
8/26/85

Wood Wastes

Wood wastes are primarily from commercial and industrial sources, especially wood products manufacturers as a residue from the manufacturing process and from both commercial and industrial sources as a waste from shipping containers and crates and from pallets. Bulky wastes and brush are not counted as wood waste.

The data from Regions I and II are presented below.

Estimated Annual Waste Wood Generation

Region I

Waste Category	Quantity (Tons)	Wood Wastes %		Wood Wastes Tons
Residential	125,000	5.3		6,600
Commercial	58,600	10.0		5,900
Industrial	105,200	16.0		16,800
			Total	29,300

Region II

Waste Category	Quantity (Tons)	Wood Wastes %		Wood Wastes Tons
Residential	81,600	1.6		1,300
Commercial	42,100	5.8		2,400
Industrial	47,600	34.4		16,400
			Total	20,100

Based on a population of 356,000 for Region I and 266,000 for Region II, the generation of wood is 0.082 tons per person per year in Region I and 0.076 tons per person per year in Region II, or an estimated 360,000 to 390,000 tons for the state. Because the Authority data did not survey sites serving only one generator, it is necessary to add in known sites of this description. For example, Thilmany Paper in Outagamie County landfilled nearly 40,000 tons of bark at its landfill in 1982. Other similar sites should be identified to develop a more accurate total.

5008Q

Food Wastes

The quantity of food wastes can be estimated by using the waste quantity and composition data obtained by the Solid Waste Recycling Authority in Region I and Region II.

Region I:

Waste Category	Total Waste (Tons)	Percent Food	Total Food (Tons)
Residential	125,200	17.2%	21,500
Commercial	58,600	11.0%	6,400
Industrial	105,000	0.8%	800
		TOTAL	28,700

Based on a population of 356,000 people, this is equal to 0.081 tons per person per year or 390,000 tons of food waste for the entire state.

Region II:

Waste Category	Total Waste (Tons)	Percent Food	Total Food (Tons)
Residential	81,600	9.0%	7300
Commercial	42,100	9.9%	4200
Industrial	47,600	2.1%	1000
		TOTAL	12,500

Based on a population of 266,000 people, this is equal to 0.047 tons per person per year or 225,000 tons of food waste for the entire state.

Conclusion

The data for Region I and Region II produce a wide range in estimated food waste quantities, ranging from 225,000 to 390,000 tons per year for the state. Most food wastes come from households.

5673Y

Yard Wastes

The quality of yard wastes can be estimated by using data obtained by the Solid Waste Recycling Authority in Regions I and II.

Region I:

Waste Category	Total Waste (Tons)	Percent Yard Waste	Total Yard (Tons)
Residential	125,200	24.1%	30,200
Commercial	58,600	-	-
Industrial	105,000	-	-
		TOTAL	30,200

This is an average of 0.085 tons per person per year, or 405,000 tons for the entire state.

Region II:

Waste Category	Total Waste (Tons)	Percent Yard Waste	Total Yard (Tons)
Residential	81,600	15.2%	12,400
Commercial	42,100	0.8%	300
Industrial	47,606	-	-
		TOTAL	12,700

This is an average of 0.048 tons per person per year, or 228,000 tons for the entire state.

Conclusions

The data for Regions I and II produce a wide range of estimated yard waste quantities from 228,000 to 405,000 tons a year. Nearly all yard waste is generated from households.

5674Y

Demolition Debris

Demolition wastes quantities can vary greatly in any specific locality depending on the amount of community or industrial redevelopment underway. Data on demolition waste quantities from the waste surveys done in Regions I and II of the former Solid Waste Recycling Authority clearly show this wide variance.

For Region I (Outagamie, Winnebago and Fond du Lac Counties), an estimated 27,200 tons of demolition waste were produced a year, equal to 0.076 tons per person per year, or an estimated 365,000 tons for the entire state.

In Region II (Lincoln, Marathon, Portage and Wood Counties), 4940 tons of demolition debris were produced each year, or 0.0186 tons per person, for an estimated total of 89,000 tons a year for the state.

In addition to these wide variances, the quantity of demolition debris may be larger than the estimates would indicate, since the operators of "one-time disposal sites" for these wastes are not required to contribute to the Waste Management Fund and the total listed quantity of waste landfilled in Wisconsin does not include these materials.

Bulky Wastes

Bulky wastes consists of large furniture, appliances and similar items. An estimate for large metal appliances was given earlier as 50,000 tons a year.

In Region I, the Recycling Authority estimated annual generation of bulky wastes was 11,500 tons or 0.032 tons per person, for an estimated 154,000 tons for the entire state for a year.

In Region II, the Recycling Authority estimated bulky waste generation at 6240 tons a year, or 0.023 tons per person, for an estimated 112,000 tons of bulky waste a year. Subtracting out the 50,000 tons of large metal appliances leaves a net bulky waste estimate of between 62,000 and 104,000 tons a year.

5668Y
7/25/85

Metal

There are two general categories into which metal wastes can be classified: large appliances, often classified as bulky wastes; and metal waste mixed in with household commercial and industrial waste. This latter category can be further subdivided to separate out aluminum and steel cans. Automobile and other vehicles are not included in this analysis, since most are collected by salvage or recycling companies, with few landfilled. Also excluded are metallic wastes in construction and demolition debris.

Appliances

Although data are not available for Wisconsin, a 1976 article in Closing the Circle, a solid waste management newsletter of UW-Extension, placed the national average for discarded appliances at 11 tons per 1000 people per year. For Wisconsin, this is approximately 52,000 tons per year.

Metal Mixed in With Waste

Estimate 1

The final report for implementation of recycling Region I of the Recycling Authority listed the quantities and composition of metallic wastes in 1975 as follows:

Category	Total Waste (Tons)	Percent Metal	Total Metal (Tons)
Residential	125,200	7.5%	9,400
Commercial	58,600	5.5%	3,200
Industrial	105,000	5.3%	5,600
		TOTAL	18,200

Based on a population of 356,000 people, the amount of metal waste produced on a per person basis is 0.051 tons a year or 244,000 tons for the entire state.

Estimate 2

The preliminary engineering report for Region II of the Recycling Authority gave the quantity and composition of metallic wastes in 1979 as follows:

Category	Total Waste (Tons)	Percent Metal	Total Metal (Tons)
Residential	81,600	6.6%	5,400
Commercial	42,100	8.5%	3,600
Industrial	47,600	9.9%	4,700
		TOTAL	13,700

With a population of 266,000 people, this is equivalent to 0.052 tons per person per year or 246,000 tons per year.

Aluminum and Steel Cans

According to data from the beverage industry, in 1982, Wisconsin consumers used 649,500,000 cans for beer and 779,500,000 cans for soda. Industry sources also state that nearly all of the beer cans are aluminum at 24 cans per pound. For soda, an estimated 90% are aluminum, with the remainder being bi-metal cans (aluminum top and steel body) at approximately 9 cans per pound (Metal Can Shipments Report, 1979, Can Manufacturers Institute). Thus, the total weight of aluminum soda and beer cans is approximately as follows:

Annual Weight of Beverage Cans Used in Wisconsin
(In Tons)

Category	Aluminum	Bi-Metal
Beer	14,100	-
Soda	15,300	4,300
TOTAL	29,400	4,300

For food and other canned products, the Can Manufacturers Instutute reports that the national usage for 1983 was 29.5 billion steel cans weighing an average of 0.190 pounds per can and 1.4 billion aluminum cans weighing an average of 0.054 pounds per can. If Wisconsin consumers use the same number of non-beverage cans per person as the national average, the quantity of non-beverage steel cans is approximately 57,000 tons and the quantity of non-beverage aluminum cans is approximately 800 tons. Thus the total amount of metal used for cans is estimated as follows:

Annual Weight of Cans Used in Wisconsin
(In Tons)

	Aluminum	Bi-Metal and Steel
Beverage	29,400	00
Non-Beverage	800	57,00
TOTAL	30,200	61,300

Conclusion

The estimated quantity of metallic wastes produced in Wisconsin is about 50,000 tons of appliances and 245,000 of metal mixed in with residential, commercial and industrial waste. This latter category includes metal cans, for which an estimated 30,000 tons of aluminum cans and 61,000 tons of steel cans are produced. Not all of these metallic wastes are landfilled as many landfill operators set aside appliances for recycling and a significant portion of the aluminum cans (an estimated 45%) are also recycled.

5672Y
7/25/85

Plastics

Plastics are found in a wide range of both durable and non-durable products including plumbing, automobiles, furniture, appliances, and packaging. For some products, such as plumbing, the useful life spans many years and the plastic produced in a specific year may not become a waste until many years in the future. For other products, such as plastic film or containers used in packaging, the material generally becomes a waste material in the same year it is produced. For example, the Aluminum Recycling Casebook, published by the Aluminum Association in 1981, gives the following data for the estimated life cycle of various categories of products:

Product Category	Life Cycle in Years
Packaging & Containers	1
Consumer Durables	10
Transportation	10
Machinery & Equipment	20
Building & Construction	35
Other	10

For the entire nation, the following chart describes the end use of plastics in 1983 (from Modern Plastics, January 1984).

U.S. Plastics Production
1983

Product	Tons
Appliances	426,000
Building	4,315,000
Electrical/Electronics	777,000
Furniture	410,000
Housewares	549,000
Packaging	4,752,000
Toys	289,000
Transportation	682,000
Trash bags	555,000
Export	1,629,000
Other	3,981,000
TOTAL	18,365,000

It is apparent from these two tables that the majority of plastics are in products with a 10 year or greater lifetime, and are either as a component of another product (such as furniture) or would be mixed in with another waste type (such as plastics used in buildings as part of construction and demolition waste).

Based on these national data, if Wisconsin is a typical consumer of plastics, total consumption of plastics in Wisconsin is estimated at 335,000 tons/year. Excluding the categories of applicances, bulky, construction, and demolition wastes, the average per capita use of plastics in 1983 was 84 pounds per person, or 200,000 tons for the State of Wisconsin. Included is an estimated 95,000 tons of packaging plastics, and 11,000 tons of plastic trash bags.

Packaging plastics can be further subdivided by separating out plastic containers from other packaging materials. According to data from Current Industrial Reports, Plastic Bottles, the annual U.S. consumption of plastic resin for use in bottles is as follows:

U.S. Plastic Bottle Resin Use
1983
(Millions of Pounds)

High Density Polyethylene	1,249
PET	365
Polyvinyl Chloride	118
Polypropylene	57
Low & Medium Density Polyethylene	58
All Other	6
TOTAL	1,853

According to these data, if Wisconsin consumes plastic bottles at the same rate as the national average, it would use about 19,000 tons of plastic bottles. However, data from the milk and soda beverage industries in Wisconsin puts total state use of plastic milk bottles at approximately 180 million a year (about four times the national per capita average) and plastic soda bottles at 17 million a year (about 28% of the national per capita average). At two ounces per plastic milk bottle and 2.9 ounces per plastic soda bottle, the breakdown for plastic bottles in Wisconsin is estimated as follows:

Annual Plastic Bottle Use in Wisconsin

Milk bottles	11,200 tons
Soda bottles	1,500
Other bottles	11,800
TOTAL	24,500 tons

Thus, Wisconsin uses about 5,500 tons more plastic bottles than the national averages would predict, boosting our use of plastic packaging to 100,500 tons and our total use of plastics to 340,500 tons.

Conclusion

Plastics are contained in many products, often in combinations that make it difficult to separate the plastics from the other materials. An estimate of plastics use in Wisconsin is given in the next table.

Estimated Plastics Use in Wisconsin
(Tons Per Year)

Containers	
Milk bottles	11,200
Soda bottles	1,500
Other bottles	11,800
Other Packaging	76,000
Trash bags	11,000
Bulky, Construction, Demolition	132,000
Other	97,000
TOTAL	340,500

5670Y
2/20/86

Glass Containers

Four estimates were made of the approximate quantity of waste glass produced in Wisconsin using the data of the Solid Waste Recycling Authority surveys, the UW-Green Bay study and data from industry sources.

Estimate 1

In the final report of the Solid Waste Recycling Authority for Region I, the quantities and composition of wastes in 1975 were given as follows:

Waste Category	Total Waste (Tons)	Percent Glass	Total Glass (Tons)
Residential	125,200	11.8%	14,770
Commercial	58,600	2.0%	1170
Industrial	105,000	0.4%	420
		TOTAL	16,360

The population of Region I was 356,000; thus, the generation of waste glass was 0.046 tons per person per year or, for the entire state, 215,000 tons.

Estimate 2

In the preliminary engineering report for Region II, the Solid Waste Recycling Authority gave the quantity and composition of wastes for 1979 as:

Waste Category	Total Waste (Tons)	Percent Glass	Total Glass (Tons)
Residential	81,600	8.0%	6,530
Commercial	42,100	1.9%	800
Industrial	47,600	2.2%	1,560
		TOTAL	8,380

The population of Region II was 266,000; the generation of waste glass was therefore 0.032 tons per person per year or 148,000 tons for the state.

Estimate 3

In November 1974, students from 35 high schools in eastern Wisconsin separated household waste under a research project sponsored by the University of Wisconsin - Green Bay under a National Science Foundation Grant. Almost 1,300 families with a total of nearly 6,700 people participated in this survey. A similar survey was done in six southern states in April 1972. Because this survey did not include commercial or industrial wastes, the data will be less than the true quantities of waste glass available. The results of the survey are as follows:

Household Waste Glass
(Kilograms Per Person Per Day)

Category	Wisconsin	Southern States
Clear Glass	0.069	0.067
Colored Glass	0.045	0.028
TOTAL	0.114	0.095

Multiplying the data for Wisconsin by the state's population and 365 days per year gives an estimate of household waste glass at 219,200 tons per year.

Estimate 4

Data from beverage industry sources indicate that in 1982, Wisconsin consumers used 170,997,000 non-refillable bottles for beer and 43,968,000 non-refillable bottles for soda. According to statistics of the U.S. Department of Commerce publication Current Industrial Reports. Glass Containers, the average non-refillable beer bottle weighs 0.4734 pounds and the average non-refillable soda bottle weights 0.5313 lbs. Thus, for the state, the weight of non-refillable beer bottles is approximately 40,000 tons and for non-refillable soda bottles is 11,700 tons.

For refillable bottles, the beverage industry data indicate that in 1982, Wisconsin consumers used 409,660,000 refillable bottles for beer and 301,632,000 refillable bottles for soda. Beverage industry officials in Wisconsin estimate an average of 10 trips for each beer bottle and 20 trips for each soda bottle, thus, an estimated 40,966,000 returnable beer bottles and 15,081,600 returnable soda bottles were discarded. At an average weight of 0.6099 pounds per beer bottle and 1.095 pounds per soda bottle, this is equal to 12,500 tons of glass for returnable beer bottles and 8300 tons of glass for returnable soda bottles.

Finally for food and other glass containers, it is assumed that Wisconsin consumers use approximately the same amount per person as do people in other states, or based on data of the 1982 Current Industrial Reports, about 56.7 pounds per person per year. For the entire state, with 4.78 million people, this equals 135,500 tons. Combining these data, the estimated generation of waste glass in Wisconsin in 1982 is:

Category		Tons Per Year
Non-refillable beverage		
Beer		40,000
Soda		11,700
Refillable beverage		
Beer		12,500
Soda		8,300
Food, Other		135,500
	TOTAL	208,000

Conclusion

Using the four methods described above, the quantity of waste glass produced in Wisconsin is estimated at from 148,000 tons a year to 219,000 tons a year. Ironically, the largest estimate, which would appear to be the most accurate because it is based on a large sampling of waste generators, covers only household generators and does not include commercial or industrial sources of glass.

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Textiles and Leather

Textiles and leather are a relatively small part of solid waste, as shown by the data in the following table:

Estimated Annual Textile and Leather Waste

Region I

Waste Category	Quantity (Tons)	Textiles and Leather %	Tons
Residential	125,200	2.1	2,600
Commercial	58,600	0.9	500
Industrial	105,200	0.9	2,500
		Total	5,600

Region II

Waste Category	Quantity (Tons)	Textiles and Leather %	Tons
Residential	81,600	4.8	3,900
Commercial	42,100	1.6	700
Industrial	47,600	0.4	400
		Total	4,800

Dividing these totals by the population in each region gives an estimate of 0.0157 tons per person per year in Region I and 0.0180 tons per person per year in Region II, for a statewide estimate of 75,000 to 86,000 tons per year.

50090

Tires

Tires are a small, but difficult to handle portion of solid waste. According to an unpublished 1977 UW-Extension report on waste tires, about 3.6 million automobile tires and 510,000 truck and bus tires were discarded in 1976. At 20 pounds per auto tire and 100 pounds per truck and bus tire, this was equal to about 62,000 tons a year. Nationally, tire sales have been relatively constant over the last 10 years. For automobile tires, for example, 1974 national sales were 174.4 million, 1979 sales were 186 million, and 1983 sales were 180 million.

Based on the above information, the estimated annual generation of waste tires in Wisconsin is probably between 60,000 and 65,000 tons per year.

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MISCELLANEOUS WASTE

The last five categories of waste listed in Table 1 include pottery cull, alum sludge, municipal wastewater treatment plant sludges, hazardous waste, and a final listing of other, unknown wastes.

The estimates for both pottery cull and alum sludge were obtained through personal contact with landfill operators that reported to the Waste Management Fund that they disposed of materials in the category of "all other solid waste not designated as non-hazardous." The listed quantity of pottery cull is landfilled at one site, while the alum sludge is disposed of in two facilities in the state.

The estimates for municipal wastewater treatment plant sludges and for hazardous waste are directly from the records of the Waste Management Fund.

It is not clear whether the materials listed as sludges are residues from primary and secondary treatment systems, or whether they are grit, bar screenings, and similar materials. Also, there are some inconsistencies of these statistics with data reported by operators of municipal sewage treatment systems to the Municipal Wastewater Section, Bureau of Wastewater Management. These discrepancies are relatively minor, on the order of approximately 25,000 tons per year.

The quantities of hazardous waste disposal reported to the Waste Management Fund includes only those wastes from large generators and licensed hazardous waste facilities and excludes household and small quantities of commercial hazardous waste. Wisconsin no longer has a licensed hazardous waste facility and recent federal and state laws have expanded their coverage to include all generators of more than 100 kilograms of hazardous waste per month. Thus, the quantity of hazardous waste currently being landfilled in Wisconsin has decreased significantly since 1983.

The final category in Table A-1 lists those wastes which have not been identified by composition. This quantity was calculated so that the total in Table 1 agrees with the total quantity of waste reported to the Waste Management Fund.

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APPENDIX B

ALTERNATIVE WASTE REDUCTION AND RECOVERY TECHNOLOGIES AND TECHNIQUES

ALTERNATIVE WASTE REDUCTION AND RECOVERY TECHNIQUES

Under the state solid waste recycling and resource recovery policy (state statute 144.792), the preferred hierarchy for the management of solid waste is:

- waste reduction
- waste reuse
- recycling
- composting
- energy recovery
- land disposal

In this appendix, a general summary is given of the technologies and techniques of each of these approaches. Appendix C gives estimates of the potential quantity of waste that can be management by each of these alternatives.

Waste Reduction

The basic philosophy of waste reduction (also called source reduction) is that some items which become solid waste should never be manufactured, and that products should contain fewer materials and/or have a longer product life. As a solid waste management technique, waste reduction can have lower environmental, social and economic costs than other forms of resource recovery or landfilling. Reducing waste at its source results in reductions in the costs of solid waste collection, transportation, processing, and disposal as well as reductions in the energy use and pollution resulting from the processing of raw materials into final products, and their transport to the consumer. However, given the standard of living that our society has come to expect, the elimination of all waste is impossible. It has been suggested though, that a certain portion of solid waste is generated unnecessarily, and could be eliminated without major changes in the standard of living. This reduction in the amount of waste at the source of manufacture is one of the major aims of waste reduction techniques.

The technical options identified for achieving waste reduction are: 1) reduced resource use per product, 2) increased product lifetime, and 3) decreased consumption of consumer products. The following paragraphs will examine each option.

Reduced Resource Use Per Product - This option for source reduction involves the design of products and/or their packaging so that minimum quantities of particular materials are used in their manufacture. This approach results not only in a reduction in the amount of raw materials used and therefore solid waste produced, but also a reduction in the energy required to process raw materials, fabricate the products, and transport them to the consumer.

Most products already include the minimum use of materials as a design criterion, however, other design criteria such as strength margins of safety, re-design costs and appearance, presently take preference in many cases. Significant savings of raw materials (20-25 percent) and hence reductions in solid waste have been estimated for new designs for steel cans, glass bottles, shipping cartons, newspapers, and tape.

Presently, about 50 percent of the nation's paper, eight percent of the steel, 75 percent of the glass, 40 percent of the aluminum, and 30 percent of the total plastics output are used solely to wrap and decorate consumer products. An added long term benefit of packaging reduction is the dollar savings to both the producer and consumer. One dollar out of every $11 spent on groceries goes to packaging, which works out to $400 per year for the average family of four.

Since containers and packaging account for about 33 percent of the total waste stream, much of the effort in reducing resource use has been concentrated in this product category.

For example, the State of Minnesota has developed packaging guidelines to review new or revised packaging or containers sold at the retail level. The guidelines are intended to determine whether the package or container will constitute a disposal problem or be inconsistent with the environmental policies of the state. The packaging guidelines were originally intended as a regulatory measure, but strong industry opposition and enforcement difficulties led to their use as guidelines.

In California, the State Solid Waste Management Board established a Source Reduction and Packaging Committee in January, 1975. This committee was given the task of preparing a report on recommended ways to reduce solid waste generation. The report was presented in March, 1976. The committee, which included industry, government, citizen, and environmental group representatives unanimously recommended voluntary waste reduction measures. The conclusions about other methods such as product regulations, taxes on packaging, and disposal charges were mixed.

Throughout the nation, food co-ops provide an alternative to purchasing over-packaged products. Consumers are able to purchase in bulk and provide their own containers, thus reducing the need for extra packaging materials which eventually would become waste.

Waste reduction is particular effective in management of hazardous wastes. Techniques include the use of more efficient manufacturing processes, in-plant recovery systems, and the substitution of non-hazardous materials for hazardous materials. In Wisconsin, a 1979 survey estimated the annual generation of hazardous waste at approximately 300,000 to 500,000 tons. By 1984, however, the total had been reduced to 125,000 tons a year. Further reductions are also possible.

Increased Product Lifetime - This approach to waste reduction involves an increase in the length of time that a consumer product remains in use. This increase in the time from purchase to disposal can have significant impacts throughout the economy. For example, if the lifetime of an item was increased 10 percent, the total number of the item produced, sold and disposed would decrease by 10 percent. This could cause reduced employment in mining, manufacturing and retailing, along with the positive effects of decreased resource usage and disposal needs. The greatest prospects for increased product lifetime are with "consumer durables" such as appliances, televisions, radios, furniture, and tires. Household appliances contribute about one percent of the solid waste stream, and tires contribute another percent.

Product lifetime is difficult to control. It is not only a function of the durability of the original design, but also the rate of technical obsolescence, changes in style or fashion, the repairability of the original design, and other factors. One method of lengthing product lifetime is to require minimum warranties for durable products.

Decreased Consumption of Consumer Products - The previous two options for source reduction involved a change in either the character of a product or in the number of times a product is reused. This option responds more directly to the problem of solid waste generation because it involves the reduction in the absolute number of consumer products used per person. The basis of this concept is the premise that consumption of certain products by individuals could significantly decrease without affecting the standard of living. This option involves the logical elimination of some of the waste which is generated unnecessarily. For example, the elimination of single-item bagging would reduce packaging wastes directly without significantly compromising convenience. Also, urban garden programs help reduce the generation of wastes associated with packaged vegetables.

Waste Reuse

This approach to waste management involves switching from single-use products or packaging to multiple-use items as well as repairing and rebuilding items for reuse. The product or packaging is reused without changing its original form (e.g., reusable packaging boxes, returnable beverage containers, reusable plates and cutlery, etc.). Although the product or packaging is used without reprocessing or refabrication, the secondary use is not necessarily the same as the primary use (e.g., old tires used in playground construction).

This option has most frequently taken the form of mandatory beverage container deposit legislation for beverage containers. This approach could theoretically be applied to many types of reusable containers such as milk containers, non-carbonated beverage containers, motor oil containers, or any other periodically purchased product.

An example of mandatory deposit legislation is the Michigan Bottle Bill. As a result of this law, beverage container litter at Michigan's 82 state parks and recreation areas declined an estimated 90 percent in 1979. In addition, 15,000 tons of aluminum and steel and 65,000 tons of glass are being recycled each year instead of buried in landfills because of the deposit law. The final report of the special joint committee to study the impact of the Bottle Bill states that the net impact on jobs in the state is approximately 4,500 additional jobs. The evidence indicates that more jobs were gained in Michigan than were lost as a result of the deposit law.

Another approach for reuse is to repair or rebuild products. For example, many of the consumer durable items that are discarded have potential usefulness for other consumers. Many communities in Wisconsin and other states have "clean-up" days in which any item placed at the curb in residential areas will be collected and hauled away. In Michigan, Detroit has shown that a significant number of items such as furniture, tires and old appliances have been exchanged instead of going to the landfill. Product repair and reuse, as promoted by such charitable organizations as Goodwill Industries, extends product lifetime while providing job training for the

physically handicapped. This technique is one good way to recover more useful life from discarded items. Garage sales and second-hand stores also help increase product lifetimes.

Reuse also has a significant potential for products used by industrial waste generators. Wooden pallets can be repaired, metal barrels can be reconditioned, equipment can be remanufactured. While many businesses use these techniques, others are unaware of these services.

As an example of another approach, the Creative Reuse Center in Grand Rapids, Michigan is a non-profit organization that obtains a wide range of reusable surplus materials from various businesses. These businesses receive a tax credit for donating and delivering materials to the Center. The donated materials include map board, paper, wood, and paper stock materials, and are available to community schools, organizations and individuals at no cost. Regular workshops are held to provide information on using materials from the Center or from the household. A card file of "reuse ideas" is located at the Center.

Food cooperatives also provide an opportunity for materials reuse since customers bring containers to be refilled and reused.

Recycling

Recycling consists of the manual or mechanical separation of waste into components that are physically and/or chemically reformulated into new products. Typical examples include the recycling of old newspapers into chipboard, animal bedding, cellulose insulation or newsprint, or the recycling of ferrous scrap by a steel mill or cast iron foundry.

Typically, recycling programs are classified by the method used to collect the materials -- pickup of the materials at the curbside or from the generator; drop-off centers where the generator brings the material to a center where no payment is received; and buy-back programs, where the generator brings the material and is paid for them. There are over 600 community curbside and drop-off recycling collection programs in Wisconsin, along with over 300 businesses operating buy-back programs.

For household waste, curbside collection of recyclable materials recovers a larger portion of the solid waste stream than drop-off or buy-back centers, for several reasons:

1) It is more convenient for participants, thus more people deliver recyclables to the curb.

2) It may reduce the cost of solid waste disposal to the participant if a user fee solid waste collection system is in effect.

Curbside collection can be done in several ways. The materials may be collected weekly, bi-weekly or monthly. The materials can be picked up on the same or a different day than regular solid waste collection. The source separated materials may be set out each pick up day in individual containers or all mixed in one bag or container and separated at the processing facility.

Curbside collection programs require consistent participation to be cost-effective. A minimum participation rate of 30-35 percent of the households in Grand Rapids, MI is necessary to make the program effective. This community has a voluntary participation program with bi-weekly collection of source separated glass, metals, plastic milk jugs, and newspaper. All the recyclables except newspapers are placed in a clear recyclable materials bag for collection on a regular waste collection day.

Boulder, Colorado also has a voluntary participation curbside collection program that involves residential and some commercial recycling. Currently, 16,800 tons are recycled annually, diverting about 15 percent of the waste steam. The program is operated by a non-profit organization and serves the 90,000 residents of the city. Ecocycle has been extensively involved in a block leader program to involve more people in the program. In the two regions of the city where the block leader program has been put into place, 70 percent of the residents participate.

Some communities have mandatory participation programs which can significantly increase participation and the impact on the waste stream. Prairie du Sac, with a population of about 2,200, has a mandatory curbside program with virtually 100% of the residents participating.

Although curbside collection programs are convenient for the homeowner, they also require more equipment and labor than an equivalent drop off or buy-back centers. The added costs of curbside collection need to be compared to the added value of the material collected, and waste diverted from the landfill.

For commercial and industrial waste, pickup services are available from recycling firms where economical. Many businesses separate materials for recycling, especially ferrous and non-ferrous metals and paper, but also wood pallets, barrels and drums, cooking oils and greases, animal fats, and other materials.

The recycling center option provides a location for people to deliver or "drop-off" recyclable materials. These centers can be as simple as unattended containers or as complex as facilities fully equipped and staffed for the receipt, processing and storage of materials. These sites may be located at shopping centers, transfer stations, in commercial and industrial areas or on city or county property. All rely on the participant to haul their own recyclables to the center with no monetary reward.

Individual drop-off sites can also be satellite sites which are linked to a central facility for processing, bulk material storage, and marketing.

In general, recycling centers have low capital investments. They also usually have lower participation rates than curbside collection programs although centers at some rural landfills have achieved over an 80% reduction in landfill needs in Wisconsin.

Recycling centers may be the only feasible recycling program in the more rural communities. Ideally, several sites might collectively market materials to be able to negotiate for better prices. The regionalized marketing concept works well in New Hampshire where their Resource Recovery Association acts as a broker for all community recycle centers in the entire state.

Drop off centers typically receive only household generated waste. Large volumes of commercial and industrial waste, are usually either picked up, or sold at the buy-back centers.

The buy-back center is similar to the drop-off center except that the person who brings in the materials receives payment for them. While recycling businesses have operated for generations as buy-back centers, in the past their focus has been on commercial and industrial waste. Although many recycling businesses retain this focus, others emphasize the purchase of household generated materials, primarily aluminum cans, glass, newspaper, and plastic.

Composting

Composting is the controlled biological decomposition of organic material in the presence of oxygen to produce humus. Composting is suitable both for food and yard wastes, as well as for paper, sewage sludge and other organic materials.

Composting can be initiated by either the waste generator or the local solid waste management agency. Homeowners, for example, can use mulching lawn mowers, use grass clippings and leaves as mulch, or compost these materials. Once collected, food and yard wastes can also be composted in centralized facilities. Madison and Brookfield, for example, both compost leaves. In a statewide demonstration project, Columbia County is composting mixed waste in combination with municipal sewage sludge.

Other waters can also be composted. Consolidated Papers Inc. is composting pulp and paper mill sludge; composted animal manure is widely sold for use in gardens.

Waste to Energy Incineration

In this report, five alternative technologies for burning municipal solid waste to generate energy are discussed. They are:

1) Mass burning of solid waste in large-scale incinerators.
2) Refuse derived fuels (RDF).
3) Small-scale or modular incinerators.
4) Pyrolytic conversion of solid waste to energy.
5) Fluidized-bed combustion of solid waste.

As of mid 1984 tnere were 59 energy recovery systems in operation in th U.S., including 10 large scale incinerators, 34 small scale incinerators, 11 RDF systems and 4 systems of other design.

Mass Burning of Solid Waste in Large-Scale Incinerators

There are two types of furnaces used to mass-burn solid waste to recover energy:

1) Refractory lined
2) Waterwall

In a refractory-lined furnace, a type of heat-resistent brick lines the wall of the furnace with heat recovery occurring downstream of the furnace in waste heat recovery boilers.

Waterwall furnaces have tubes of water in the combustion chamber walls to both help control the temperature of combustion and to absorb the heat and generate steam, which can be utilized as an energy source.

Large scale mass burning of refuse to generate energy is not a new technology. Between 1890-1910, energy recovery incinerators were constructed and operated in Hamburg, Paris, Zurich, and New York. Presently, there are over 368 such facilities in operation throughout the world.

Mass Burning Process

Solid waste is received from collection vehicles during the hours of operation at the plant. The solid waste is dumped into a concrete pit large enough to store several days' supply. The extra capacity is needed because most plants operate seven days a week, 24 hours a day, while accepting waste only five or five and one-half days a week.

Most large scale mass burning plants have large overhead cranes to charge the furnaces with the solid waste. The crane is utilized to mix the solid waste thereby enhancing the uniformity of moisture content. The crane drops the solid waste into a charging hopper that regulates the flow into the furnace. In some designs, the air seal to the furnace is maintained by sliding gates, which close the furnace off from the hopper, while in other designs, the solid waste stacked in the charging hopper serves as an air seal. The air from the bunker, which can contain large amounts of dust and has strong odors, is drawn into the furnace as primary air. This prevents odor problems in the area surrounding the facility.

The incinerator consists of a refractory walled chamber or a tube lined walled chamber with a series of grates. The refuse is pushed into the furnace from the feed hopper, where it is then dried and heated. As the temperature rises, the refuse begins to burn. By the end of the grate system, the refuse should be completely burned. The ash then falls into the ash processing system from the last grate. Primary air for the burning is introduced upward through the grate system. The gases and heat produced rise up into the boiler system. The grates support the refuse, provide even primary air distribution, and agitate refuse to fill voids and expose new burn surfaces.

The boiler system is either a waterwall or convection type unit (used with a refractory lined furnace). In both systems, the air rises up out of the furnace and into the boiler system which is located above the furnace. In both systems, the boiler water is changed into steam which removes energy from th air passing through the boiler. The air leaves the system at a reduced temperature and volume, thereby reducing the needed size of the air pollution equipment. The steam produced is used directly for heating and/or cooling, in industrial processes, or for generating electricity.

The ash from the furnace falls into a water sump or quench tank. The ash is continuously removed from the sump by a drag conveyer or some form of hydraulic ram or pusher. The ash is then discharged into an ash bunker or a

processing system for ash recycling. The water sump forms an airtight seal between the furnace and ash handling system. Many of the large-scale mass burn incinerators incorporate magnetic separation in the ash handling system to recover ferrous metal. Some incinerator ash has been found to contain toxic levels of heavy metals.

Electrostatic precipitators are usually used for control of particulate emissions. New units are often required to include scrubber units following electrostatic precipitators to remove acid-forming gases to prevent formation of hydrofluoric acid and hydrochloric acid in the atmosphere. Fly ash from the electrostatic precipitator or baghouse is conveyed to the ash bunker to be disposed of or recycled.

Dioxins and other organic compounds are controlled by maintaining high combustion temperatures at specific retention times.

Refuse Derived Fuel (RDF) Systems

The development of RDF (refuse derived fuel) technology is uniquely American and differs from mass burning in that the solid waste is processed in a front-end plant by mechanical shredding and sorting. The original impetus for producing RDF, as opposed to mass burning, was to develop a fuel from solid waste that could be burned in existing boilers, thereby eliminating the expense of designing and construction a special facility just for burning solid waste.

RDF is a prepared fuel using solid water as its raw material. The solid waste is shredded to create uniform-size particles of combustible materials composed of both cellulose (paper, wood) and organics (plastics, food wastes, yard wastes). Noncombustible materials (metals, glass, inert materials) are removed by various separation processes. RDF production consists of the following:

1) Receiving and storage of the solid waste.
2) Size reduction (primary and sometimes secondary shredding)
3) Magnetic separation
4) Screening
5) Air classification
6) Storage of RDF

Other processes that are sometimes included in RDF preparation are drying, air cleaning, densification, separation of non-ferrous metals, and various additional kinds of cleaning to remove the non-burnables.

Common methods for receiving and storing solid waste prior to preparation as RDF includes receiving floors serving as storage areas, with the handling being done by front end loaders; pits with conveyers on the bottom moving the solid waste into the process line for primary shredding; and storage pits with overhead cranes. In most process lines, problem items such as gas tanks and LPG containers are picked out by hand prior to primary shredding.

Reducing the size of the solid waste is the core of the RDF process line. The reduction is usually performed in two stages, primary (coarse) shredding and secondary (fine) shredding. Various types of equipment are used, including:

- Flail and hammermills are used to cut or tear large pieces of paper, cardboard, rags, cans, boxes and plastic containers into a certain size;

- Secondary hammermills further reduce the size of the primary shredded material.

Explosions can be a problem in dry-shredding operations, therefore, explosion-control techniques must be utilized to minimize the effect of any explosion.

Magnetic separation devices include electrically activated magnets on rotary drums and moving belts. The magnets remove the ferrous metal and it is then sold to scrap dealer for recycling. Depending on the market for scrap, this may or may not be a significant source of income.

Screening removes undersized and noncombustible material from the waste stream. Vibrating screens, trommels, and disc screens are the usual devices used.

Air classification is used to separate light material from the RDF and to remove heavier unwanted non-burnables. This generally completes the fuel's preparation. Although there are a number of air classifiers used, many re proprietary systems offered by RDF vendors.

One of the main reasons for developing RDF is its potential diversity as a fuel source. RDF can be burned in a grate, in suspension, or in semi-suspension. The equipment available includes spreader stoker boiler systems, suspension fired in dedicated boilers or supplementally fired in either oil or coal utility or industrial boilers.

The different burning units demand different qualities of RDF. The design and operation of an RDF plant determines what fuel quality levels can be produced.

RDF production is a new technology. While mass burning of solid waste has more than 40 years of operating history, RDF development did not begin until the late 1960's. Early developmental work was supported by the federal government, but for the last half of the 1970's and continuing to the present, the RDF process has been developed by a limited number of vendors, communities, and consulting firms.

Small Scale or Modular Energy Systems

Small scale incinerator technology is similar to mass burning in that solid waste is not processed prior to burning. There are two basic combustion processes used in small scale systems, the starved air and the excess air processes.

Starved air system consists of two or more combustion chambers. The primary chamber is operated in an oxygen deficient condition; the amount of air provided is not equal to the amount needed to achieve complete combustion.

The secondary chamber completes the combustion of the partially burned compounds coming from the primary chamber. Excess air conditions exist in the secondary chamber to assure complete combustion. The amount of air is varied to control the temperature.

The purpose of the two chambers in a starved air system is to reduce gas velocities and the amount of entrained air pollutants leaving the incinerators, thereby reducing the amount of air pollution control equipment needed to meet air quality standards.

Waste is fed to starved air units either in batches or continuously. The solid waste is then moved along by either rams, moving grates, rotary primary chambers, or a rotary auger. Ash residue is removed from th small scale system either by batch dumping, or continuously through the use of conveyors.

The excess air small scale systems are similar to conventional excess air large scale systems, only sized down. However, some of the small scale systems use an unconventional design such as a rotary waterwall combustor.

The original small scale modular systems were relatively inexpensive. However, with the advent of more stringent air pollution regulations and because of technical improvements to the system, cost have increased dramatically over the last several years. As an example, in 1977, a facility in North Little Rock, Arkansas cost $14,500 per ton of design capacity. A similar system installed in Windham, Connecticut in 1981 cost $41,250 per ton of design capacity. Cost increases can be attributed not only to inflation and interest rates, but to changes in design and operating practices.

Pyrolytic Conversion of Solid Waste to Energy

Pyrolysis is thermal degradation in the absence of oxygen. At the present time, there are no pyrolytic conversion plants in the U.S. utilizing solid waste at a fuel. There were several pilot and demonstration projects built during the 1970's, but all are now shut down.

The organic portion of solid waste is similar to chemical composition to cellulose. As heat is applied to solid waste in the absence of oxygen, the various chemical constituents present in the waste are released. The degree of conversion that can occur depends on the various chemicals present, the temperature, and the rate of reaction. The main products from a pyrolytic reaction are a condensable oil, carbon char, and methane. The advantage of the pryolysis unit is that the fuel can be utilized by a conventional fuel oil furnace or boiler.

Pyrolytic reactors are heated either directly or indirectly. Direct heating involves a combustion zone inside the reactor,fed by oxygen or air. Supplemental fuel such as coke or oil may be used. Indirect heating requires a system to heat the reactor from the outside. An indirect heater can take the form of a jacket or tubes surrounding the reactor.

Pyrolysis is a complex process and has been beset by serious operating problems. Although changes in system design and operating practices are

theoretically possible to bring these very persistent problems under control, there still is not a full scale solid waste pyrolysis plant in operation in the U.S. today.

Fluidized Bed Combustion of Solid Waste

Fluidized bed combustion was developed for the petroleum industry and has been used for burning pulverized coal and sewage sludge. Generally, fluidized bed combustors have a high rate of heat transfer, can burn many diverse materials, and can be applied in many configurations. The only U.S. plant utilizing this technology for solid waste is located in Duluth, MN. The plant was built to use processed solid waste as a fuel in the fluidized bed combustor to burn sewage sludge. Operating problems have been so severe with the Duluth facility that it is burning wood chips for fuel instead of solid waste.

A fluidized bed combustor is a vessel containing a bed of inert material, such as sand. As air is passed up through the bed, the bed floats (i.e., becomes fluid) and begins to agitate and turn over. The air flow is carefully controlled to maintain the integrity of the bed and prevent bed material from being blown out of the vessel. The bed material is heated by burning fuel, with the heat transferred out of the bed by devices such as heat transfer tubes. A variety of fuels can be burned in the bed, including many waste materials.

As gases from combustion leave the bed, they enter into the expanded upper area of the fluidized bed combustor vessel, or free board, where additional combustion occurs and the velocity of the gases is reduced. The gases are then cleaned before being emitted into the atmosphere.

The application of fluidized bed combustion technology to solid waste is in its infancy. Research needs are quite extensive just for that application, but there are also great gaps generally in understanding fluidized beds regardless of the feedstock used. Northern States Power is exploring the use of its fluidized bed combustor in La Crosse for converting solid waste into energy.

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APPENDIX C

CALCULATION OF

WASTE REDUCTION AND RECOVERY GOALS

Waste Reduction and Reuse
of Municipal Waste

State policy establishes waste reduction and reuse as the first and second preferred techniques for managing solid waste. Such techniques are well known and readily implemented for industrial and hazardous waste. However, it is not possible to make firm estimates of the potential for the reduction and reuse of municipal waste.

Waste reduction studies from both Michigan and Minnesota focus on packaging materials, which comprise a third of all municipal waste. According to the USEPA, in 1971 packaging consumed 75% of all glass used in the U.S. along with 50% of all paper, 30% of all plastic, 14% of the aluminum, and 8% of the steel. The Michigan and Minnesota studies estimated that by reducing the use of packaging, it should be possible to reduce waste generation by approximately 10%. However, detailed analyses on how to implement a source reduction program were not developed for either of these states and the actual effectiveness of these approaches has not been determined. Another study, the Solid Waste Management Development Guide/Policy Plan for the Metropolitan Council of St. Paul, Minnesota, estimated that a more conservative 2% of all waste can be handled by waste reduction, but again, detailed data on implementation have not been developed.

Besides the reduction of excess packaging, other measures to encourage waste reduction and reuse for municipal waste include:

- Redesign of packaging (such as cereal boxes or milk cartons) to reduce the amount of packaging for a given volume of product. For example, a container manufacturer was able to redesign a milk carton to use 30% less material while containing the same amount of milk.

- Educational programs to alter consumer buying habits to purchase less packaging.

- Educational programs to encourage consumers to improve the maintenance of products and to repair products to extend their life. For example, studies have shown that consumers can extend the life of their automobile tires by more than double through better maintenance.

- Establish minimum product warranties, extending the lifetimes of products. For example, radial tires last two to four times as long as bias-belted tires, reducing waste generation by 50%-75%.

- Develop government purchasing policies to give priority to products that have long lifetimes and are easily repaired and maintained.

- Adopt user fees for solid waste collection and disposal based on the quantity of waste generated. Some Wisconsin communities have reduced the amount of waste landfilled by 50% to 85% through the adoption of user fees.

- Substitute reusable products for products with limited service lives, such as shipping containers, pens, lighters, razors and similar products. Unfortunately, the trend seems to be towards products with less durable materials, although Buick Motor Company has begun a policy at one of its plants to only contract with suppliers which ship products in returnable and reusable containers.

- Substitute lighter materials for heavier materials. Market forces are the primary motivation for implementing this alternative with the prime example being the use of plastic as a substitute for glass containers and the use of plastic in automobiles.

- Resale (possibly with rebuilding or remanufacturing) of products. This is already done for industrial equipment and shipping containers wood (pallets, barrels and drums), and at stores selling used appliances, books, clothing and similar items.

- Reuse of waste for another purpose. Many companies find that their chemical wastes are reusable by other companies. DNR's office memos/telephone message pads are often printed on the back of previously printed paper.

In a 1976 California study on waste reduction, an advisory committee rated 13 options for state implementation. Only four options were favored by a majority of the committee members. In priority order, the committee recommended:

1. Educational programs to encourage waste reduction.

2. User fees for waste collection and disposal.

3. Minimum product warranties.

4. State specifications to purchase products with minimal waste generation.

Although it is not possible to calculate the net impact of state efforts on waste reduction and reuse, it is recommended that Wisconsin adopt the four measures listed in the California report. In addition, it is recommended that the state work closely with manufacturers to develop products that are consistent with waste reduction and reuse policies and that the state continue to explore other opportunities for waste reduction and reuse.

5732Q

Calculation of Potential Recycling Rates For Municipal Waste

Wisconsin has over 600 community recycling collection programs, plus over 400 markets that purchase scrap. Several community recycling programs in Wisconsin have achieved a 35% to 40% reduction in the quantity of waste going to their landfill. However, because of the diversity in Wisconsin communities, it is not anticipated that this rate of recovery can be obtained for the entire state. In 1984, three years after the implementation of a comprehensive program involving educational, technical, and financial assistance funded through a state imposed tipping fee at landfills, the State of New Jersey had a 12% recovery rate for municipal wastes, with about 9% from recycling and 3% by composting food and yard waste. New Jersey has a goal to recover 25% of its waste though recycling and composting by 1986. In Minnesota, the Metropolitan Council has set a goal of 16% recycling in the seven county metropolitan area of the Twin Cities by 1990. This program is also funded in part by landfill tipping fees established by the state.

With an aggressive state program backed by adequate funding, it is anticipated that Wisconsin can achieve a high rate of recycling similar to New Jersey and the Minneapolis-St. Paul area. The goals established in this paper are based on Wisconsin waste generation data and markets. All data are expressed in terms of present waste quantities and will need to be periodically adjusted to take into account changes in waste quantities and composition.

Paper

In 1984, a record amount of paper was recycled in the U.S. Paper recycling is also increasing in Wisconsin.

According to the Wisconsin Paper Council, the use of recycled paper by Wisconsin paper mills in 1987 is forecast at 1,426,000 tons, a 40% increase over 1982, divided as follows:

Use of Waste Paper by Wisconsin Paper Mills
(1987 Estimate)

Grade	Quantity
Mixed Paper	79,000 tons
Newsprint	116,000
Old Corrugated Containers	449,000
Pulp Substitute	261,000
High Grade Deinking	521,000
TOTAL	1,426,000

Scrap paper used by Wisconsin mills comes from all parts of the country. Data are not available on the quantities collected from within Wisconsin.

The following analysis of the potential for the recycling of waste paper generated in Wisconsin is based on the waste composition data in Appendix A, the data on the use of recycled paper by Wisconsin paper mills, and data from the report, Waste Paper. The Future of a Resource 1980-2000, by Franklin Associates, Ltd. for the Solid Waste Council of the Paper Industry, copyright 1982 by the American Paper Institute, Inc. It is assumed that Wisconsin recycles the various grades of paper at about the same rate as the national recycling of these grades.

1. Mixed Paper

The paper industry report predicts that the recycling of mixed paper could rise from 2.27 million tons in 1980 to 4.97 million tons by 2000. On a proportional basis for Wisconsin, this is equal to an increase of 54,000 tons. Because of the small amount of mixed paper recycled by paper mills in the state, it is felt that even with an aggressive state program, we will only be able to achieve a slightly higher rate than the national average. Thus, a goal of a 60,000 ton per year increase has been established.

2. Newsprint

The national recycling rate for newsprint is approximately 30% with predictions of a 40% recycling rate possible by 2000. Although Wisconsin paper mills do not reclaim much newsprint, other state markets use newsprint for insulation manufacturing, animal bedding and molded paper products. In addition, firms in Illinois also reclaim large quantities of newsprint. With an active state program promoting recycling, and as more and more local communities mandate newspaper recycling, it should be possible to achieve a 50% rate of recovery. Thus, the goal is to increase the amount of newsprint recycling by:

$$140{,}000 \text{ tons} \times \frac{1}{1 - 0.30} \times (0.50 - 0.30) = 40{,}000 \text{ tons}$$

3. Corrugated

About 40% of all corrugated containers in the U.S. are recycled, and estimates for 2000 are that 52% of the waste corrugated could be reclaimed. Because of our favorable location to markets, an active program to recover corrugated should be able to recycle 60% of all corrugated produced in this state. This is equal to an estimated increase of:

$$420{,}000 \text{ tons} \times \frac{1}{1 - 0.40} \times (0.60 - 0.40) = 140{,}000 \text{ tons}$$

4. Office Paper

Office paper is classified by recyclers as high grade deinking fiber. Industry predictions are that the recycling of high grade deinking fiber could rise from 1.14 million tons in 1980 to 3.28 million tons in 2000. A proportional increase in Wisconsin is 45,000 tons. Because Wisconsin paper mills consume about 60% of all high grade deinking fiber recycled in the U.S., it is believed that most readily recoverable office paper is already being recycled and a goal of a 20,000 ton increase is established.

Metal

According to the Wisconsin Chapter of the Institute of Scrap Iron and Steel, 1.5 million tons of ferrous scrap metal are processed annually by Wisconsin scrap dealers. In addition, the state's scrap dealers process an unknown amount of non-ferrous metals including aluminum, brass, copper, lead, silver, stainless steel, zinc and other metals.

Based on the waste composition surveys of the Wisconsin Solid Waste Recycling Authority, the largest portion of metal going to landfills is from residential sources. Because of the relatively small amount of metal waste in commercial and industrial waste sources, and the active role of Wisconsin's metallic scrap dealers, it is assumed that little of these metals can be recovered. It is further assumed that for household waste, the only significant source of increased recycling is for aluminum cans. The markets are limited for tin (steel) cans (and these cans are being replaced by plastic and aluminum), most white goods (appliances) are already recycled, and other residential sources of scrap are too diffuse to economically recover.

For aluminum cans, the Alcoa Company estimates that Wisconsin recovers 45% of aluminum cans. However, in states with a mandatory deposit on beverage containers, recycling rates range up to 90% to 95%. The Department has recommended to the Legislature that mandatory deposits on beverage containers be established. At a 90% recycling rate for aluminum cans, this is an increase in recycling of:

$$18{,}000 \text{ tons} \times \frac{1}{1 - 0.45} \times (.90 - .45) = 15{,}000 \text{ tons}$$

Glass

Currently, about 7% of all glass containers in the U.S. are recycled, with a substantial portion coming from states with mandatory beverage container deposits. In Wisconsin, data from industry sources places the rate of glass recycling at about 5%. The goal for glass recycling is based on a state mandatory deposit on beverage containers, achieving an expected rate of 90% recycling, plus an assumed rate of recycling at 15% for non-beverage container glass, based on the establishment of drop off recycling centers for glass at landfills and in communities of over 10,000 people as required by 1983 Act 426.

Based on these forecasts, the increase in the amount of glass recycled is:

Beverage containers:

$$70{,}000 \text{ tons} \times \frac{1}{1 - 0.05} \times (0.90 - 0.05) = 63{,}000 \text{ tons}$$

Non-beverage containers

$$110{,}000 \text{ tons} \times \frac{1}{1 - 0.05} \times (0.15 - 0.05) = 12{,}000 \text{ tons}$$

Thus, for glass, the goal is to recycle an additional 75,000 tons. Glass recylers in Wisconsin have said that they would be able to market any additional glass collected.

Plastics

Most recycling efforts for plastics have focused on the reclamation of plastic bottles. The data on the use of plastic bottles in Wisconsin is very sketchy, but industry estimates are that Wisconsin consumers use 180 million plastic milk bottles weighing 11,000 tons, 17 million plastic soda bottles totalling 1,500 tons and about 215 million or 12,000 tons of other plastic bottles.

Although private entrepreneurs and the plastics industry are working on new ways to recycle plastics, no overall forecast can be made on the potential for recovery except for plastic soda bottles. Made from the PET, they can be recovered if collected in sufficient quantity. With a mandatory beverage container deposit law, the recovery rate is estimated at 90% or 1,350 tons.

IN SUMMARY

Based on the above calculations, a feasible recovery rate for increased recycling in Wisconsin is approximately 351,000 tons of municipal waste, as shown in the next table.

Feasible Additional Recovery Rates

Material		Tons Per Year
Paper		260,000
Mixed	60,000	
Newsprint	40,000	
Corrugated	140,000	
Office	20,000	
Metal		15,000
Glass		75,000
Plastics		1,000
	TOTAL	351,000

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Calculation of Composting Rates for Municipal Wastes

Composting of municipal wastes can focus on three waste streams -- yard waste, food waste, and mixed waste.

Yard wastes are easily composted and it is recommended that the state prohibit the land disposal of yard waste and require communities to both encourage homeowners to home compost these materials and for communities above 3,500 people to establish community composting facilities for yard wastes. At a level of 100% compliance, this will reduce landfill needs by the estimated 300,000 tons a year.

Most food waste can also be readily composted, although animal waste (fat, grease, meat scraps, etc.) are not recommended for inclusion in home composting facilities due to problems with attracting rodents, flies and similar pests. Using an estimated rate of 25% composting for food waste (this is a typical rate of participation in voluntary curbside recycling programs), the goal for composting food waste is set at 75,000 tons a year.

Mixed municipal waste can also be composted and research is underway at the Wisconsin Co-Compost Demonstration Project in Columbia County to determine the physical, chemical and economic suitability of the process and marketability of the finished product. If the results are favorable, mixed waste composting could handle a significant amount of Wisconsin municipal waste. A goal for mixed waste composting has not been established pending completion of the research project.

Because the composting of yard and food waste does not require the development of new technology, and markets already exist for the use of the finished product, it will be possible to reach these goals by 1990.

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Calculation of Energy Recovery Potential from Municipal Waste

According to Department records, in the spring of 1985 there were 21 municipal waste-to-energy systems under study or under development in Wisconsin, with a combined capacity of 3,500 to 4,000 tons per day. Because of increasing costs of solid waste disposal and as landfills need to be replaced throughout the state, it is anticipated that other communities will also examine incineration. In a study done by Wisconsin's electric utilities as part of their Advance Plan 4, it was predicted that by 2000, all of the technically processable waste (75% of the residental and commercial waste, 50% of the industrial waste) will be incinerated for energy recovery.

To calculate the potential for energy recovery in Wisconsin, the estimates of the utilities' Advance Plan 4 for the recovery of energy from residential, commercial and industrial waste were multiplied by the total of the state's municipal waste and non-hazardous waste, subtracting out the quantity of materials recovered through recycling and composting. Also subtracted are the amount of wood waste and tire waste, for which it is possible to separately recover all of these materials as a fuel for industrial or utility boilers.

Using the data from the previous two appendices, the estimated quantity of mixed municipal waste available for incineration is 1.45 million tons/year or 4,000 tons per day. Based on an 85% availability factor for incineration systems, this will require a daily capacity of 4,700 tons a day. The estimated capital cost for these facilities is approximately $300-$400 million in 1985 dollars.

To calculate the net effect of municipal waste-to-energy facilities on landfill needs, it is necessary to calculate the amount of residue remaining after the incineration process. Typical incinerators produce an ash at about 30% (dry basis) of the incoming refuse, of which the majority (70-75%) is from glass and metal. With the removal of glass, metal, paper and yard waste through the expected rate of recycling described the previous two appendices, the residue from the incineration of 1.45 million tons a year is calculated at 0.32 million tons a year, for a total reduction in landfill needs of 1.13 million tons a year. Although the residue may be further reduced through recycling as road construction material, through landspreading or by other methods, it is not possible to estimate the potential for recovery of other residue at this time.

In addition to the incineration of mixed municipal waste, there are 410,000 tons of wood waste and 60,000 tons of old tires suitable for incineration. The ash from the wood waste is calculated at 12,500 tons a year while the residue from the tires is calculated at 6,000 tons a year, yielding a net reduction in landfill needs from the incineration of these two materials of 461,500 tons a year.

Summary

Complementing recycling and composting, the recovery of energy from solid waste can reduce the quantity of landfilled waste by 1.58 million tons a year as shown in the next table.

Waste Reduction from Energy Recover : Wisconsin
(Tons a Year)

Waste Type	Quantity Incinerated	Residue	Net Reduction
Mixed Municipal	1,450,000	320,000	1,130,000
Wood	410,000	12,500	397,500
Tires	60,000	6,000	54,000
TOTALS	1,920,000	338,500	1,581,500

If suitable energy markets are available, it is feasible for this goal to be reached by 1990. However, studies in several parts of the state have not been able to locate suitable steam markets and have found the net cost of electrical generation is too high to be economically justifiable. Thus, in the absence of a state program to improve the economics of energy recovery, this goal will not be met by 1990.

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Waste Reduction and Recovery for Large Volume Industrial Waste

In 1983, 46% of all landfilled waste in Wisconsin came from three sources -- sludge from pulp and paper mills (1,517,000 tons), ashes and sludges from industrial and utility coal fired boilers (1,087,000 tons), and foundry waste (443,000 tons). For each of these materials, the long-term goal is to reduce the quantity landfilled by at least 60%-90%.

Pulp and Paper Mill Sludge

Sludges from pulp and paper mills are the largest quantity of waste landfilled in the state, and the amount landfilled has increased each year from 1981 through 1983. However, the paper industry is actively developing alternatives to the landfilling of their sludges, with over 30 waste reduction and recovery projects currently underway in the state. At the present time, the most effective strategies for reducing landfill needs are: (1) in-plant changes to use a larger percentage of the paper fiber and thereby reduce the discharge of these fibers to the wastewater treatment system, (2) dewatering the sludge prior to disposal, (3) land spreading the sludge on agricultural or silvacultural land, and (4) incinerating or processing the sludge in a wet-air oxidation system.

As examples of the effectiveness of these management alternatives, a Wisconsin paper mill expects to reduce its sludge volume by 40% with dewatering equipment currently being installed. Two other paper mills have set goals for themselves for a 90% reduction one through landspreading and the other through wet-air oxidation.

For the long-range, the Department's goal is a 75%-90% reduction in the landfilling of pulp and paper mill sludges. By 1990, Bureau staff feel a 30% reduction is feasible.

Coal Combustion Residues

In 1983, 1,087,000 tons of ash and sludge from coal burning industrial and utility boilers were landfilled in Wisconsin. This was a 4% increase over 1982, and a 16% decrease from 1981.

The predominant method of reclaiming coal ash is as a construction material. For example, in 1984, 280,000 tons of ash from Wisconsin's utilities were recycled; 160,000 tons of fly ash for use in concrete and 120,000 tons of cyclone boiler slag for use as blasting grit, roofing granules and as a substitute for sand on winter roads.

The potential for the recovery of coal ash varies by the type of ash. The ash from low sulfur western coal is known as Class C fly ash. The fly ash is cementitious in combination with water and is widely used as a replacement for a portion of the portland cement in concrete, producing a stronger, more watertight concrete than is possible by the use of portland cement alone. Eastern and mid-western coals produce Class F fly ash which has been used in concrete for over 40 years, but is not in as great a demand as the Class C fly

ash now is. This is because of the generally higher carbon content of the Class F fly ash, which is due to incomplete combustion in older, less efficient power plant units, and its lack of cementitious properties. However, when combined with lime and water, Class F fly ash will form cementitious compounds, making it desirable for use in cement-stabilized backfill slurry mix (lean mix), road base material and grouts. It was also used as highway embankment material in a 900 foot section of the I-94 Airport Spur leading into Milwaukee's Mitchell Field, where over 120,000 tons of Class F fly ash and bottom ash were placed.

In addition to fly ash, the combustion of coal also produces what is known as bottom ash, which is collected at the base of the boiler. Bottom ash is either hard and glassy like boiler slag or is a sand-like material. It is suitable for snow and ice control, structural fill, road base, as an aggregate substitute, and in numerous other applications.

In 1976 and 1977, over 120,000 tons of Class F ash were used in Milwaukee County in a 900 foot section of the General Mitchell Airport Spur highway embankment project.

The next table gives the estimated composition of landfilled coal combustion ash in Wisconsin.

Estimated Composition of Landfilled Coal Ash in Wisconsin
(Tons Per Year)

Ash Type	Fly Ash	Bottom Ash
Class C	255,000 tons	125,000 tons
Class F	445,000	79,000
Unknown	148,000	35,000
TOTAL	1,087,000 tons	

The electric industry is both promoting the use of ash where known to be feasible, as well as sponsoring long-term research on new methods for ash reclamation. In Milwaukee, the Wisconsin Electric Power Company is studying the use of ash to manufacture cinder blocks to build fish reefs in Lake Michigan and to demonstrate the long-term chemical inertness of cement-stabilized fly ash. Class C fly ash, with its high lime content, has been found to be suitable for landspreading as a liming agent on agricultural land. Federal standards and requirements for the use of coal ash in the construction of roads and other facilities have also been recently developed, and will promote the recycling of these materials.

According to the chair of the Wisconsin Utilities Association Task Force on Ash Utilization, it should be technically feasible to recover virtually 100% of the utility ash produced in the state. To do so, it would be necessary to demonstrate the benefits of using ash and to develop adequate markets. Based on this evaluation, the long-term goal for coal ash is for a 75%-90% reduction in landfilling with a 30% goal by 1990.

Foundry Waste

The quantity of foundry waste landfilled in Wisconsin has declined by 41% from 1981 to 1983, primarily because of the severe recession of the foundry industry.

Foundry sands, which comprise 40%-60% of all foundry waste, are traditionally reused within the foundry. However, not all foundries reclaim their sand and new technology has also been developed for additional reclamation, either within the plant or through independent reclamation facilities. In some situations, foundry sand can also be reused as daily or final cover at landfills, as construction fill, and as an additive for pavement.

Besides sand waste, foundries also produce waste cores and air pollution control residues. New technology will be required to reclaim these wastes.

The Department's long-term goal is a 60%-70% recovery, with a 1990 goal of 30% recovery.

In Summary

For large volume industrial waste, a long-term goal is for a 60%-90% recovery of the waste. Acts 410 and 426, Laws of 1983 establish several financial and regulatory incentives to promote the reduction and recovery of these materials. Additional legislation will be introduced in the 1985-86 legislative session to promote recycling. Administrative Code changes to NR 180 will also be developed in 1985 or 1986 to facilitate the recovery of large volume industrial waste.

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Waste Reduction and Recovery for

Municipal Wastewater Treatment Plant Sludges

According to the Department records, municipal wastewater treatment plants in Wisconsin annually produce about 8 1/4 to 8 V2 million tons of wet sludge. The majority of this sludge is either landspread for reuse or is incinerated with only 14,000 tons (0.15%) being disposed of in landfills. This high level of reuse is in part due to the active Department program in promoting landspreading and assisting local municipalities in the beneficial reuse of sludge. The Department is continuing to promote municipal sludge reuse, with a goal to further reduce the amount landfilled.

Waste Reduction and Recovery for

Hazardous Wastes

In 1983, Wisconsin generated an estimated 125,000 tons of hazardous waste of which 31,000 tons were landfilled, including 8,000 tons in Wisconsin, accounting for about 0.1% of all landfilled waste in the State. At the current time, Wisconsin does not have a licensed hazardous waste disposal facility and no regulated hazardous wastes being landfilled in the State.

Using the hierarchy of waste reduction, reuse, recycling, and energy recovery in preference to landfilling, the state goal is to minimize the land disposal of hazardous wastes. Under waste reduction, the Industrial Wastewater Section promotes improvements in manufacturing processes and wastewater treatment to minimize waste generation. Many companies have found that non-hazardous materials can be substituted for hazardous waste producing raw materials. Under reuse, the Department is promoting participation in the Midwest Waste Exchange, where companies with hazardous wastes advertise for users of these materials. Recycling of waste materials is being encouraged by state statutes and Department regulations under NR 181 as well as with financial assistance from the waste reduction and recycling demonstration grant program. Energy recovery is also feasible for ignitable wastes. While there will always be a need to landfill some hazardous wastes, the state goal is to reduce this quantity to the maximum extent feasible.

APPENDIX D

STATE STATUTES AND ADMINISTRATIVE CODES APPLICABLE TO WASTE REDUCTION AND RECOVERY

State Statutes and Administrative Codes Applicable to Waste Reduction and Recovery

ss. 59.07(133) - Allows counties to require the use of recycling or resource recovery facilities (flow control).

ss. 59.07(134) - Allows counties to acquire recycling or resource recovery facilities without bids.

ss. 61.345 - Allows villages to require the use of recycling or resource recovery facilities (flow control).

ss. 61.57 - Allows villages to acquire recycling or resource recovery facilities without bids.

ss. 62.155 - Allows cities to acquire recycling or resource recovery facilities without bids.

ss. 62.225 - Allows cities to require the use of recycling or resource recovery facilities (flow control).

ss. 70.11(21) - Provides property tax exemption for waste treatment plants and pollution abatement equipment.

ss. 70.995(2)(x), (y), (z) - Provides a property tax exemption for manufacturing equipment, including certain waste recycling equipment for scrap metal, waste paper, fiber, plastic and for hazardous waste treatment facilities.

ss. 71.04(2b), (2g) - Allows for rapid depreciation, amortization or expensing of waste treatment equipment.

ss. 77.54(5)(c), (26m) - Grants an exemption from sales and use taxes for waste reduction and recycling equipment.

ss. 144.43(5) - Exempts certain recycling facilities from the definition of solid waste (also see NR 180.04(45), (51), and (58)).

ss. 144.44(2)(f)7. and 8. - Requires solid waste land disposal feasibility reports and feasibility reports for hazardous waste treatment, storage or disposal to examine alternatives of waste reduction and recovery.

ss. 144.44(7) - Allows waivers from the land disposal feasibility and licensing process for the recycling and beneficial use of high volume industrial wastes (coal combustion residues, foundry sands and pulp and paper mill sludge).

ss. 144.48 - Establishes requirements for waste oil recycling facilities in communities of 3500 or more people (also see NR 183).

ss. 144.781-144.784, 144.799 - Establishes the solid waste management grant programs (also see NR 185 and NR 186).

ss. 144.792 - The state recycling and resource recovery policy, placing a priority on waste reduction, reuse, recycling, composting and energy recovery over the landfilling of materials.

ss. 144.794 - Provides flow control powers to local units of government for recycling and resource recovery.

ss. 144.795 - Describes state assistance programs on waste reduction and recycling.

ss. 144.796 - Establishes requirements for waste separation and recycling collection facilities in communities of 10,000 or more people and at landfills open to the public.

ss. 144.797 - Describes state assistance for low technology recycling.

NR 154 Air pollution control regulations. NR 154.04 defines facilities which must obtain construction and operation permits. An exemption is provided for certain facilities modified to burn municipal waste as an alternate fuel. NR 154.11 regulates particulate emissions, NR 154.145 sets standards for lead emissions. NR 154.18 gives requirements for malodorous emissions control and NR 154.19 describes requirements for the control of hazardous pollutants.

NR 180.05 Plan review fees and license fees are waived for processing facilities and incinerators which have a primary purpose of recovering material or energy.

NR 180.10 Regulations applicable to solid waste processing facilities. Exempted are single family composting facilities, and certain facilities for recycling scrap iron, steel, nonferrous metal, paper, fibers and plastics if not mixed with other solid waste.

NR 180.11 Solid Waste Regulations applicable to incinerators.

NR 180.17 Regulation of salvage yards.

NR 180.20 Standards for exemption from requirements of NR 180, including exemptions for beneficial utilization of waste materials.

NR 181.19 Provides regulatory exemptions for certain hazardous waste recycling facilities.

NR 440 New source performance standards for air emissions; NR 440.21 establishes standards for incinerators with a waste loading of more than 50 tons a day.

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11/21/85

APPENDIX E

PUBLICATIONS ON

WASTE REDUCTION AND RECOVERY

AVAILABLE FROM THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Bibliography of Public Information Publications
on Recycling and Resource Recovery
Available from Wisconsin DNR

A. Laws, Rules and Policies

1. Wisconsin's 1984 Recycling Act, June 1984, 2 pp.
2. Solid Waste Flow Control for Recycling or Resource Recovery, DNR, 1984, 4 pp.
3. Special Study Grant Requirements, DNR, September 1984, 2 pp.
4. Recycling Ordinances, DNR, April 1985, 2 pp.
5. Waste Oil Recycling Law, 1 p.

B. Recycling

Markets

1. Recycling Markets for Wisconsin, DNR, January 1984, 137 pp.

Aluminum

1. Alcoa's Guide to Starting A Successful Aluminum Can Recycling Center, Alcoa, 1979, 16 pp.

Waste Paper

1. UW-Madison Office Paper Recycling, Wisconsi Solid Waste Recycling Authority, 1 p.
2. Fluctuations in Waste Paper Prices (chart), Wisconsin Solid Waste Recycling Authority, 1 p.

Newspaper

1. Animal Bedding from Shredded Paper (brochure), Portage County UW-Extension and Wisconsin Center for Public Policy, 1982.
2. Plans For a Manual Newspaper Baler, Publishers Paper, No Date, 4 pp.

General

1. Recycling and Solid/Hazardous Wastes. Agencies and Organizations, DNR, November 1984, 2 pp.
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3. Recycling Efforts in Small Cities. The Role of Citizen Volunteers, DNR, March 1984, 11 pp.
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5. Summary Report of the 2nd National Recycling Congress, Boulder, CO., 1983, DNR, 41 pp.
6. Summary of the 2nd Annual Illinois Recycling Conference, 1983, DNR, 30 pp.
7. Wisconsin Natural Resources Special Recycling Edition, DNR, July, 1985, 48 pp.
8. Promoting Recycling in Wisconsin (Speech Outline), DNR, January 1985, 5 pp.

9. Wisconsin's Recycling Program (Speech Outline), January 1985, 5 pp.
10. Environmental Shopping List, Spring 1981, 2 pp.
10. Environmental Impacts of Recycling, Wisconsin Solid Waste Recycling Authority, 2 pp.
11. Energy Conservation Through Recycling, National Association of Recycling Industries, 2pp, no date.

Manuals

1. Build a Recycling Center At Home, DNR, 1 pp.
2. Conserving and Recycling Solid Waste, DNR, 1 p.
3. Developing and Implementing a Mandatory Source Separation Ordinance, Wisconsin Center for Public Policy, 2 pp.
4. Source Separation Collection and Processing Equipment, A User's Guide, U.S. EPA, 1980, 57 pp.
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7. Community-Based Waste Recycling. How to Get Started, UW-Extension, 1984, 4 pp.
8. Source Separation Recycling, Wisconsin Center for Public Policy, 1983, 2 pp.

Teaching Guides

1. Recycle for Reuse (4H Guide), UW Extension, Publication 4H 362, 1985, 45 pp.
2. Audio Visual Aids on Recycling, DNR, October 1985, 26 pp.
3. Crafts from Trash, Wisconsin Center for Public Policy, April 1984, 8 pp.
4. Operating A Recycling Program: A Citizen's Guide, U.S. EPA, 1979, 96 pp.

Community Recycling Programs

1. Recycling Leaves in Madison, Wisconsin Center for Public Policy, December 1982, 1 p.
2. Brown Deer Recycling Program, Wisconsin Solid Waste Recycling Authority, April 1981, 2 pp.
3. Madison Recycles Newspaper, Other Wastes, Wisconsin Solid Waste Recycling Authority, June 1983, 3 pp.
4. Community Recycling Activities, DNR, October 1985, 19 pp.
5. Wisconsin's Community Recycling Collection Programs Directory, DNR, October, 1985, 67 pp.

Waste Oil

1. Waste Oil Markets DNR, February 1985, 2 pp.
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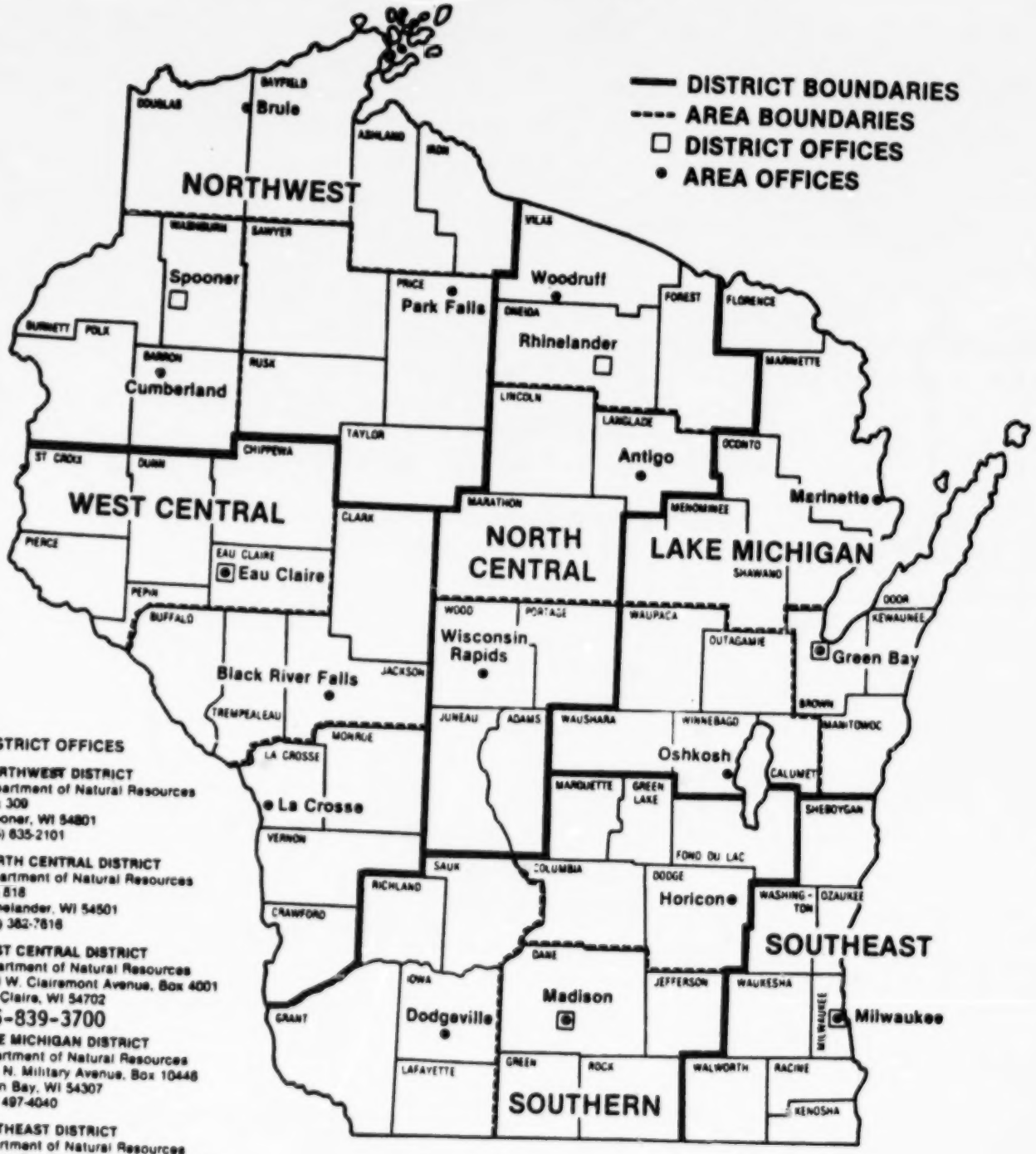
DNR FIELD DISTRICTS AND AREAS



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OUR MISSION:

To protect and enhance our Natural Resources —
our air, land and water;
our wildlife, fish and forests.

To provide a clean environment
and a full range of outdoor opportunities.

To insure the right of all Wisconsin citizens
to use and enjoy these resources in
their work and leisure.

And in cooperation with all our citizens
to consider the future
and those who will follow us.

WISCONSIN
DEPT. OF NATURAL RESOURCES